CALIFORNIA STATE MINING BUREAU.

HENRY G. HANKS, STATE MINERALOGIST.

SIXTH ANNUAL REPORT

OF THE

STATE MINERALOGIST.

PART I.

FOR THE YEAR ENDING JUNE 1, 1886.

SACRAMENTO.
STATE OFFICE.........JAMES J. AYERS, SUPT. STATE PRINTING.
1886.

CALIFORNIA STATE MINING BUREAU.

HENRY G. HANKS, STATE MINERALOGIST.

SIXTH ANNUAL REPORT

OF THE

STATE MINERALOGIST.

PART I.

FOR THE YEAR ENDING JUNE 1, 1886.

SACRAMENTO:
STATE OFFICE.............J. J. AYERS, SUPT. STATE PRINTING.
1886.

From Pres. Office

To his Excellency GEORGE STONEMAN, *Governor of California:*

SIR: I have the honor herewith to submit the sixth annual report of the State Mineralogist, and report of progress of the California State Mining Bureau, for the year ending June 1, 1886, prepared in accordance with the Act of Legislature, approved April 16, 1880.

Permit me to express my thanks to you and to other State officials for courtesies extended to me, and for the interest you have taken in the State Mining Bureau.

I have the honor, sir, to remain very respectfully,

HENRY G. HANKS,
State Mineralogist.

REPORT.

HISTORY OF THE STATE MINING BUREAU.

A very full history of the California State Mining Bureau, from its commencement in 1880 to the fifteenth of May, 1885, may be found in the five annual reports which precede this. The history includes a relation of the many difficulties met with in the establishment of the institution, which it will not be necessary to repeat here.

The Board of Trustees appointed by Governor Stoneman, in accordance with an Act of the Legislature (Assembly Bill No. 78, which passed the Assembly February 11, 1885, and the Senate March 5, 1885), organized April 18, 1885.

The following gentlemen constitute the Board: William Irelan, Jr., S. Heydenfeldt, Jr., J. Z. Davis, Walter E. Dean, and George Hearst. William Irelan, Jr., was elected Chairman, and S. Heydenfeldt, Jr., Secretary.

The Act providing for a Board of Trustees is published in full in the fifth annual report of this office.

Immediately on the return of the State Mineralogist from the New Orleans Exposition, preparation was made for removal to the fine fireproof building recently erected by the Society of California Pioneers. The building is situated on Fourth Street, near Market, on the property donated to that society by James Lick.

The removal, which was made during an unusually rainy season, was nevertheless finished without serious loss from breakage, and the entire time, up to the date of this report, has been employed in placing the museum in order.

The collection of seven thousand catalogued specimens, and many not yet entered, is arranged in cases, and classified into seven principal groups, as follows: MINERALS, ORES, ROCKS, FOSSILS, SHELLS, ETHNOLOGY, and SUNDRIES. The whole should now be rearranged into geographical divisions. This, by my calculation, would require the entire time of an industrious man for one year, as I have planned to do it. From this may be inferred the estimate I place on the magnitude and importance of the State Museum at the present time.

While the exhibition of the State minerals at New Orleans was worth far more than the cost necessitated by twice packing and thrice removing the specimens, it set back the work of the Mining Bureau for six months. The removal to the new building, and arrangement of the museum, occupied three months more. The specimens are now all in place, and I am pleased to state that no serious loss, or material injury from breakage, or otherwise, has been sustained.

PRESENT CONDITION OF THE STATE MINING BUREAU.

The condition of the institution is most satisfactory. The State is now in possession of a very extensive museum, which has cost but a trifle compared with its actual value.

It would have been impossible to make so large and varied a collection, even if many times the money expended had been at the disposal of the State Mineralogist, were it not that prospectors were willing to send to the State Mining Bureau many fine and interesting specimens in return for information extended to them. The State is greatly indebted to Wells, Fargo & Co., and the several steamship companies, for free transportation.

The museum is one of which the people should be proud.

Mr. Joseph Wasson, to whom the State of California owes a just debt of gratitude, gave the future of the State Mining Bureau much thought, and nobly made the foundation broad and ample. But the institution has grown more rapidly than even he expected, and while it is at the present time in a healthy and prosperous condition, its future should be made the subject of careful legislation.

The institution has been carried through many difficulties, and has been placed in a safe and suitable building, and the financial management transferred to a Board of Trustees, who will care for it in the future. There is money enough to keep it alive until the meeting of the next Legislature. The museum is still growing, and will continue to do so. It is to be hoped that the next Legislature will make sufficient provision for its support.

From the experience I have made during a period of six years while holding the office of State Mineralogist, it is my opinion that the State Museum should be entirely separated from the office of State Mineralogist, and all the responsibility of that department removed from him. He should be provided with the necessary assistants and money (which need not be a large sum). The money for the support of his office, which is really the most important branch of the State Mining Bureau, should be entirely under his control, and he should be allowed to manage his department according to his own judgment, without interference from the Board of Trustees, he bearing the responsibility.

DONATIONS.

Many valuable specimens have been presented to the museum during the past year, and I regret that, owing to reasons mentioned elsewhere, it has been impossible to present in this report a full list of the names of those who have thus enriched the State Museum by their generous donations. I take this occasion to acknowledge, generally, the receipt of many valuable gifts which have been placed in the museum cases when it has been possible to do so. Others will be arranged and catalogued in due time.

CORRESPONDENCE.

This department has grown in proportion to the advance of the institution, and to that extent that it is now fully the work of one individual during business hours to care for it properly. I am sorry to say that the numerous letters received by the State Mining Bureau have not always been answered as promptly as they should have been—addressed as they were to an important institution in one of the most important States of the American Union. I can only offer as an excuse the utter impossibility of doing better, for reasons too often repeated in the reports of this office. The State Mining Bureau numbers among its correspondents scientific societies, State and foreign governments, and noted individuals, besides many citizens of the Pacific Coast, wishing information as to the natural resources of California. When it has been possible to do so, all procurable information has been given. The reputation of California as a mineral-producing State

is so widespread, and so much is expected of the Mining Bureau and the State Mineralogist, that it is a matter of regret that his work has been impeded for want of needed assistance in this department.

CHEMICAL WORK.

Since Mr. Edward Booth, the very efficient chemist employed during the first year of the Mining Bureau, was discharged for want of funds, nearly all the chemical work has been done in the private laboratory of the State Mineralogist, maintained at his own expense. The work has been considerable, but not in proportion to the requirements of the office. Some of the results will appear elsewhere in this report.

LIBRARY.

Very few volumes have been added to the library. Since the administration of the Board of Trustees a few valuable works have been purchased and a few acquired by donation.

VISITORS.

The number of visitors to the museum has gradually increased. Since the removal to the new rooms the increase has been very noticeable.

PUBLICATIONS.

The reports of this office, although below my standard, are much in demand, showing the interest taken by the world in our affairs. These reports should be made fuller and better with each issue; but this cannot be done until the State Mineralogist is furnished with more assistance and money with which to visit the localities in the State where valuable minerals are found. No matter how industrious he may be in collecting and arranging matter for his publications, unless he has clerical assistance to carefully revise the work, annoying and discreditable errors will be found when it is too late to correct them in the too hastily prepared reports. For these reasons the publications are not without certain crudities. If the most valuable parts of each volume were carefully revised, provided with maps and engravings, reprinted in one, and published officially, a volume would be so produced which might be given a wide circulation, to the advantage of the State.

SACRAMENTO STATE COLLECTION OF MINERALS.

There is at the Capitol, in the State Library, in rooms wanted for books, a large and valuable collection of minerals, which was purchased many years ago by the State at an expenditure of a considerable sum of money. It is my opinion that this collection should be joined to the one now in the Pioneer Building in San Francisco, to which it would form a fine supplement. Repeated efforts have been made to effect this union, but always with opposition. Still it seems to be the proper thing to join them.

STATE MAPS.

Considerable work has been done and much data collected with a view to the publication of a preliminary geological map of the State, and a large

map in sections, on a scale of one centimeter to the mile, on which it was intended to mark the exact locality of all valuable minerals found in the State. It is to be hoped that this work will be continued. An appropriation of several thousand dollars would not be too much for this alone.

CATALOGUE.

A portion of the third volume of the museum catalogue has been printed, which brings the numbers up to seven thousand. When the entries number nine thousand this volume will be put into book form by the State Printer.

ORIGIN OF THE NAME CALIFORNIA.

In preparing a history of the geological surveys and explorations of California, I frequently met with the statement that the name of our State was derived from a Spanish romance, published first in 1521. This was ignored or contradicted by other authors. I became very much interested in this subject, and wrote to the Librarian of the British Museum, asking him if there was such a work in his library. In due time a reply came from G. K. Fortescue, the Librarian, informing me that there was, and that in Chapter 157 the name California appears. Mr. Fortescue kindly offered to have the chapter copied for me, which I accepted, and received the chapter in Spanish, which follows this. I then applied to Mr. Camilo Martin, Consul for Spain, who made for me a literal translation, in which he aimed to reproduce in English the quaint idiom of the original.

In his first letter, Mr. Fortescue gave me certain references, which led to my finding in the Proceedings of the American Antiquarian Society, April 30, 1862, a paper on this same subject, by Edward Everett Hale, in which he quotes a few lines from the romance.

As the commander of the expedition sent out by Cortez did not discover Lower California until 1534, and as the romance was so popular that it passed rapidly through a number of editions, it is reasonable to infer that the name California had its origin in the fertile brain of the author. Mr. Hale seems to have been the first to discover and publish these facts.

LAS SERGAS del muy esforzado Caballero Esplandian, hijo del excelente Rey Amadis de GAULA.—Madrid, 1521.

CAPITULO CLVII.

Del espantoso y no pensado socorro con que la reina Calafia en favor de los turcos al puerto de Constantinopla llegó.

Quiero agora que sepais una cosa la mas extraña que nunca por escriptura ni por memoria de gente en ningun caso hallar se pudo, por donde el dia siguiente fué la ciudad en punto de ser perdita, y cómo de alli donde le vino el peligro le vino la salud. Sabed que á la diestra mano de las Indias hubo una isla, llamada California, muy llegada á la parte del Paraiso Terrenal, la cual fué poblada de mujeres negras, sin que algun varon entre ellas hubiese, que casi como las amazonas era su estilo de vivir. Estras eran de valientes cuerpos y esforzados y ardientes corazones y de grandes fuerzas; la insula en si la mas fuerte de riscos y bravas peñas que en el mundo se hallaba; las sus armas eran todas de oro, y tambien las guarniciones de las bestias fieras, en que, después de las haber amansado, cabalgaban; que en toda la isla no habia otro metal alguno. Moraban en cuevas muy bien labradas; tenian navios muchos, en que salian á otras partes á hacer sus cabalgadas, y los hombres que prendian llevábanlos consigo, dándoles las muertes que adelante oiréis. Y algunas veces que teinan paces con sus contrarios, mezclábanse can toda seguranza unas con otros, y habian ayuntamientos carnales, de donde se seguia quedar muchas dellas preñadas, y si parian varon, luego era muerto. La causa dello, segun se sabia, era porque en sus pensamientos tenien firme de apocar los varones en tan pequeño número, que sin trabajo los pudiesen señorear, con todas sus tierras, y guardar aquellos que entendiesen que cumplia para que la generacion no pereciese.

En esta isla, California llamada, habia muchos grifos, por la grande aspereza de la tierra y por las infinitas salvajinas que en ella habitaban, los cuales en ninguna parte del mundo eran hallados; y en et tiempo que tenian hijos, iban estas mujeres con artificios para

los tomar, cubiertas todas de muy gruesos cueros, y traianlos à sus cuevas, y alli los criaban. Y siendo ya igualados, cebábanlos en aquellos hombres y en los niños que parian, tantas veces y con tales artes, que muy bien conocian à ellas, y no les hacian ningun mal. Cualquiera varon que en la isla entrase, luego por ellos era muerto y comido; y aunque hartos estuviesen, no dejaban por eso de los tomar y alzarlos arriba, volando por el aire, y cuando se enojaban de los traer, dejábanlos caer donde luego eran muertos. Pues al tiempo que aquellos grandes hombres de los paganos partieron con aquellas tan grandes flotas como la historia vos ha ya contado, reinaba en aquella isla California una reina muy grande de cuerpo, muy hermosa para entre ellas, en floreciente edad, deseosa en su pensamiento de acabar grandes cosas, valiente en esfuerzo y ardid de su bravo corazon, mas que otra ninguna de las que antes della aquel señorio mandaron. Y oyendo decir cómo toda la mayor parte del mundo se movia en aquel viaje contra los cristianos, no sabiendo ella que cosa era cristianos, ni teniendo noticia de otras tierras, sino aquellas que sus vecinas estaban, deseando ver el mundo y sus diversas generaciones, pensando que con la gran fortaleza suya y de las suyas, que de todo le que se ganase habria por fuerza ó por grado la mayor parte, habló con todas aquellas que en guerra diestras estaban, que seria bueno que, entrando en sus muy grandes flotas, siguiesen aquel viaje que aquellos grandes principes y altos hombres seguian; animándolas y esforzándolas, poniendoles delante las muy grandes honras y provechos que de tal camino seguirseles podrian, sobre todo con muy grande fama que por toda el mundo dellas seria sonada, que estando así en aquella isla, haciendo no otra cosa sino la que sus antecesores hicieron, no era sino estar como sepultadas en vida, como muertas viviendo, pasando sus dias sin fama, sin gloria, como los animales brutos hacien.

Tantas cosas les dijo aquella muy esforzada reina Calafia, que no solamente movió á sus gentes á consentir en el tal camino, mas ellas, con mayor deseo que sus famas por muchas partes divulgadas fuesen, le daban priesa que entrase en la mar luego, porque se hallesan en las afrentas, juntas con aquellos tan grandes hombres. La Reina, que la voluntad de las suyas vido, sin mas dilatar, mandó bastecer su grande flota de viandas y de armas todas de oro, y de todo lo demás necesario. y mandó reparar la mayor fusta de las suyas, hecha á manera de una red de gruesa madera, y hizo en ella meter hasta quinientos grifos, que, como ya se vos dijo, desde pequeños mandó criar y cebar en los hombres; y haciendo allí meter las bestias en que cabalgaban, que de diversas maneras eran, y todas las mas escogidas mujeres y mejor armadas que tenia en la flota, dejando tal recaudo en la isla con que segura quedase, y metióse ella las otras en la mar; y dióse tanta priesa, que llegó á las flotas de los paganos aquella noche que se os dijo del combate; con que todos ellos hubieron muy gran placer, y luego fué visitada de aquellos grandes señores, haciendole muy grande acatamiento. Ella quiso saber en qué estado estaba su hecho, rogándoles mucho que por extenso se lo contasen, y oida la relacion dello, dijo: "Vosotros habies combatido esta ciudad con vuestras grandes gentes, y no la pudístes tomar; pues yo con las mias, si á vosotros pluguiere, quiero el dia siguiente probar mis fuerzas á que bastarán, si quisieredes estar á mi consejo." Todos aquellos grandes señores le dijeron que como por ella fuese señalado, que asi lo mandarian cumplir.

"Pues enviad luego á todos los otros capitanes que por ninguna manera salgan mañana ellos ni los sujos de sus estancias, hasta que por mi les sea mandado, y veréis un combate el mas extraño que hasta hoy nunca vistes, ni de que jamás oistes hablar." Esto fué luego hecho saber al gran soldan de Liquia y al soldan de Halapa, que tenia cargo de todas las huestes que estaban en la tierra; los cuales así lo mandaron á todas sur gentes, maravillándose mucho á qué podria acudir el pensamiento y obra de aquella reina.

TRANSLATION.

The Exploits of the very valiant Knight Esplandian, son of the excellent King Amadis of Gaul.—[Madrid, 1521.]

Chapter CLVII.

The marvelous and not thought of succor with which the Queen Calafia came to the Port of Constantinople in favor of the Turks.

I wish you now to know a thing the most strange which ever either in writing or in people's memory could be found, by which the city was the following day on the point of being lost, and how from there where the danger came, salvation came to it. Know then that to the right hand of the Indies, there was an island called California, very near the part of the terrestrial Paradise, and which was inhabited by black women, without there being among them even one man, that their style of living was almost like that of the Amazons. They were of robust bodies and valiant and ardent hearts and of great strength; the island itself was the strongest that could be found in the world through its steep and wild rocks; their arms were all of gold and also the harness of the wild beasts on which they rode after taming them, as there was no other metal in the whole island; they dwelled in well-finished caves; they had many ships in which they went to other parts to obtain booty, and the men whom they made prisoners they took along, killing them in the way you shall hear further on. And sometimes, when they were at peace with their adversaries, they used to mingle with them with entire confidence; if any of them gave birth to a son, he was put to death at once. The reason for it, as it was known, was because in their thoughts they were resolved to lessen the men to so small a number that they would be able to master them without much trouble, with all their lands, and preserve those who would understand that it was convenient to do so that the race might not perish.

In this island, called California, there were a great many griffins, the like, on account of the ruggedness of the land and the very many wild beasts therein contained, were not found in any other part of the world: and when they had little ones, these women would go covered with thick skins to catch them by tricks, and they would bring them to their caves and there rear them; and when they were accustomed to them, they would feed them with those men and with the male children they bore, so often and with such cunning that they very well learned to know them, and never did them any harm. Any man who landed on the island was at once killed and eaten by them; and though they might be glutted, they would not the less take them and lift them up, flying through the air, and when tired of carrying them, they would let them fall, where they would be killed at once. Well, at the time when those great men of the pagans departed with those large fleets, as history has already told you, there reigned in said Island California a Queen very tall of stature, very handsome for one of them, of blooming age, desiring in her thoughts to do great deeds, valiant in spirit, and in cunning of her fearless heart, more so than any of the others that before her reigned in that seigniory. And having heard how the greatest part of the world was moving in that expedition against the Christians, she, not knowing what beings were the Christians, nor having any knowledge of other countries except those which were next to hers, wishing to see the world and its different races, thinking that with her great valor and that of her adherents all that would be gained she would have, by force or by cunning, the largest share of, she spoke with all those that were skillful in war, telling them that it would be well that, going in their great fleets, they should follow the same road that those great princes and eminent men were taking, inciting and encouraging them by laying before them the very great honor and gain that might result to them from that undertaking; above all, the great fame that would resound in the whole world about them; that remaining in the island as they were, doing nothing but what their ancestors had done, would be only to be buried in life, like living dead, passing their days without fame and without glory, like wild animals.

So many things said to them by that very valiant Queen Calafia, that she not only moved her people to consent to the undertaking, but they, with their great desire that their fame should be published in many parts, hurried her to put to sea at once, so as to happen to be in the danger jointly with those great men. The Queen, who saw the determination of her people, ordered her great fleet to be supplied with provisions, and with arms all of gold and with all other necessaries; and she ordered the repairing of her largest vessel, made like a grate of thick timbers, and she had put into her up to five hundred griffins, which, as you have been told, she had raised from tender age and fed with the flesh of men, and having therein also put the animals on which they rode, and which were of different kinds; also, the best chosen and best armed women which were in the fleet, and, leaving such garrison in the island as to be secure, she put to sea with the others, and she hurried so much that she joined the fleets of the pagans the night of the combat, of which you have been told, which caused them all very great pleasure, and then she was visited by those great lords, who showed her great reverence. She wanted to know in what state was their enterprise, begging them to relate it to her minutely; and having heard the report from them, she said: "You have fought this city with your many people and could not take it; well, I with mine, if it is agreeable to you, will, on the following day, try the reach of my power, if you will accept my advice." All those great lords answered her, that whatever was by her indicated, they would order it executed. "Then notify at once all the other commanders that to-morrow, on no account, they nor theirs leave their quarters, until it is so ordered by me, and you shall see a fight the most strange never seen before this day, and of which you never have heard spoken." This was then made known to the great Sultan of Liquia and the Sultan of Halapa, who had charge of all the armies which were on land, and who thus ordered their people, wondering much what could be the thought and deed of that Queen.

GENERAL CONDITION OF MINING IN CALIFORNIA.

California is just emerging from a condition of things that will be remembered for many years to come with regret and astonishment, and which will pass to history as one of those periodic manias which come over mankind like a calamity and shake the very foundations of society.

If the majority of the people of the Pacific Coast should be informed that instead of having been engaged in mining, they have simply been gambling, and have in the most foolish manner possible, given up their money to a comparatively few unscrupulous and dishonest sharpers, they would be slow to admit the fact, yet perhaps in the annals of history, there has never been such a wholesale transfer of money from a multitude of pockets to a few, without consideration, under the deceptive but fascinating name of mining.

Stock gambling is in no sense mining. It is a favorite excuse by those who have lost their savings in this way, to say sadly, "I invested all my

money in mines and lost it," which most of them did not, but bought worthless stocks instead. To recount the most successful deceptions that have been practiced to induce those who had money to invest it in stocks, would fill many pages and leave much more to be said. Still honest gold and silver mining presents the best field for the investment of capital of any business in California, for the following reasons:

Gold is becoming scarce, and consequently its purchasing power is greater than it has been for many years. The market for gold is in no way dependent on the population of the Pacific Coast; while a large population is essential to render manufacturing successful. We can produce gold with perfect confidence that the market of the world will gladly take all we are willing to spare, and in return will manufacture for us cheaper than we can hope or desire to do for ourselves.

Mines can now be worked in California at a much less cost than during the delirium of the first gold excitement, for the reason that transportation, provisions, labor, and fuel are cheaper; and every ounce of gold obtained is practically of double value. These facts are well known to intelligent miners in the State, and our mines are being better worked than ever before. New quartz veins are being taken up wherever they can be found; and there are indications of a new era in mining, which, it is to be hoped, will cause renewed prosperity in the State, even if we cannot utilize our vast deposits of placer gold.

MINING ECONOMIES.

Within a few years railroad lines have been extended and settlements advanced. Ores that could only be worked if they would yield from twenty-five to fifty dollars per ton are now found to be rich, as they can be mined and milled at a very reduced expense. Dump piles, formerly considered worthless, are now valued at many thousands of dollars. Tailings, allowed to go to waste in former years, are now being prospected and assayed. The concentration of these tailings will furnish employment for many men in the near future.

When on a large scale gold quartz has been crushed in quartz mills, a sandy powder passes through the screens and over the amalgamating copper plates. Theoretically the gold contained in the quartz remains attached to the mercury; what flows away (which is nearly all that passes the screens) is known among miners as tailings. If the operation of milling was as perfect in practice as in theory, the tailings would be worthless, but this is not the case; not only does a considerable quantity of gold escape, but mercury also. The sulphurets, which are nearly always auriferous, are not decomposed in the operation, and carry their precious contents with them to the beds of the streams below the mills, or to the reservoirs, which the most prudent of superintendents or managers provide for the reception of the tailings. The ordinary quartz mill saves only *free* gold, and even a portion of that escapes, owing to defective milling, and the sometimes peculiar condition of the gold, which has been before referred to in these reports. Mercury is used in the batteries, and on the plates, but, notwithstanding the skill acquired by the amalgamators, and the experience of many years in California, a considerable portion escapes, taking gold with it that had already become amalgamated. To prevent this well known loss many ingenious inventors have spent years of their lives and much money in the construction of machines and in the planning of processes, many of which have been patented, until the art of concentration has reached a point approaching perfection. But there is still

room for improvement. There is a great future in California for the concentration of tailings and low grade ores which were wasted during the time of excitement, when it was found to be more profitable to extract gold and silver from the pockets of the credulous than from the mines. In this connection it is interesting to note that companies are now engaged, with large capital, in working the lead slags of Laurium in Greece, and other ancient mines in Spain, and with great profit.

The following newspaper extracts have a special bearing on this subject:

In cleaning up in quartz mills a lot of scraps of iron are always found, consisting of fragments from shoes, dies, shovels, picks, hammers, and drills; and these lumps are knocked about in the mortar until numerous particles of gold are driven into their interstices. A lot of such scraps collected in the Jefferson Mill, in Yuba County, supposed to weigh half a ton, after being broken up with sledges, were digested in warm sulphuric acid until the surface had been eaten away and the gold liberated, and the yield thus obtained was $3,000. The shoes and dies, being too large to be broken up or digested in acid, were boiled half an hour in water, and then when the iron was repeatedly struck with a hammer, the particles of gold dropped out.

The Pennsylvania Company have run a lot of tailings, formerly considered worthless, through one of Wheeler & Randall's grinding pans, and cleaned up eighty-four ounces of amalgam, worth $5 per oz.

In some comments yesterday on the new drift of mining industries, the more extreme instances of the working of low grade ores were not cited. In Calaveras County during the last two years more than eighty thousand tons of quartz rock have been worked by one mill, the yield of which rock was less than two dollars a ton. And yet this mine was worked at a profit—the yield per ton ranging from one dollar and eighty cents up to about one dollar and ninety-five cents. The assays show that the rock carried more gold. But this is all that could be saved by any process now known. Of course, when the yield per ton is so small, there must be many advantages of working. The quartz must be abundant, and there must be no long land transportation. It would appear from these and other facts that low grade gold quartz can be worked with as much advantage now in California as in Australia, or in any other part of the world. These facts are of special importance just now, while fresh attention has been turned to gold quartz mining in California. Gold bearing ledges will not hereafter be neglected because of low grade ores. Nothing comes amiss now in that way from two-dollar ore in good situations up to twenty-dollar quartz in more remote and less accessible districts.

The value of the gold in the tailings not only of the quartz mines, but the hydraulic mines, is something enormous. It is considered by the most practical miners in California that at least one half the gold in placer mining is lost—or, rather, not saved. The loss of mercury may be reckoned by hundreds, if not thousands, of tons. This can to a great extent be recovered by reworking and concentration. This subject is well worthy the attention of laborers and capitalists.

IMPORTANCE OF GOLD AND GOLD MINING.

It cannot be denied that the love of gold is widespread, intense, and universal. It is vain to argue that gold is not an absolute necessity—to say that we cannot eat or wear it; that it is heavy and cumbersome—for we learn both in ancient and modern history that from the earliest ages mankind would sacrifice almost everything else for gold, and would even risk their lives to obtain it. The producers of all other staples, and the manufacturers of all articles of use and luxury, will gladly transport them from the ends of the earth and lay them at the feet of the miner in exchange for his yellow gold.

During a golden age, such as that through which we have just passed, real and personal property increase enormously. Without gold it would be impossible that there should be so many men possessing great wealth,

known as millionaires. The country that produces, holds, or utilizes the most gold, makes the greatest progress, and advances most rapidly in civilization and power. The discovery of gold in California stimulated commerce and manufactures and general progress more than any event in modern history, and its effect was felt over the whole civilized world. Without it the Pacific railroads would not so soon have been built, nor would the advancement of the Pacific Coast have been so rapid.

There has never perhaps been a period when labor has been so well paid and the world progressed as during the recent golden age, for in all former gold excitements the precious metal was extracted by slave or convict labor, and enriched kings instead of the people. While it is true that the thirst for gold brings in its train many evils, it must also be admitted that it is productive of much good. It begins to be realized by the world generally what a powerful lever or motor gold is to commerce, manufactures, and trade; that on the product of distant gold fields depends the rise and fall of prices, including salaries, in countries not producing gold, and whether trade and manufactures shall thrive or languish. In the United States the importance of our gold production is too often wholly disregarded, or but slightly considered.

Gold is true wealth. It cannot be destroyed by fire or by the action of ordinary chemical agents, and will always command its bullion value in whatever state or condition it may be. It is not only wealth in itself, but is the accepted measure of all other values. There is no other description of real property that can be so readily turned to account as gold. It seeks no market; on the contrary, all branches of trade and commerce seek it.

In digging for gold, the most desired of all products, natural or artificial, the miner becomes a consumer of all other products, and has at the same time the power to purchase them, conditions which render trade or barter most active. In the exchange of commodities—the business of the merchant—nothing is produced; the world is accommodated, but actual wealth is not increased. So with the manufacturer. He adds to the value of the crude material, but adds nothing to the actual wealth of the world. The agriculturist also produces what is consumed as food, and must be reproduced from the same source. But the real wealth of the world is derived from its crude products, generally dependent upon mining. The checking of gold mining, then, in our State, becomes a very serious matter, and affects not only California, but the United States and the world. Since it can be shown that our great and exceptional prosperity for many years was owing to the advantage we derived from our prolific gold fields, is it not more than possible that we have made a great mistake in crippling the most important producers, the gold miners?

The failure of any legitimate harvest is felt far beyond the area of its production. Thus the sudden cessation of the cotton crop in the Southern States, during the civil war, was the cause of great and widespread destitution among the mill operatives of Great Britain. In the same way the decrease of the gold crop of California not only places the people of our State at great disadvantage, but is felt in the general depression of business and the stringency of the money market in the country at large.

When the supply of gold diminishes suddenly, there follows a series of financial crises, so calamitous and far reaching that the most distant lands suffer in common with us. It can be shown that the present shrinkage in values, which is distressing the laboring classes at home and abroad, is the direct result of this decrease of gold, and is only a repetition of what has occurred many times in history under similar conditions.

If you ask ten men of average intelligence the cause of the present

general stringency of the times, the uneasiness of capital, the clashing between laborer and employer, the uprising of the many against the few, the stagnation of trade the world over, the apparent overproduction of manufactures and crude material, each would give a different answer, and probably none of them would be the full solution of the question. The primary and immediate cause is the scarcity of gold. Other minor influences are generally local, and nearly all of them hinge on the former.

The best thinkers and financiers of Europe assume that the production of gold is less than the requirements, and gold coinage is nearly suspended.

Assuming, therefore, the fall of prices to be caused by the diminished gold production, we must admit that if this were gradual, it would occasion no serious distress. It is the *sudden* diminution that causes the disturbance. Our people have the same elements of prosperity, but cannot divert the property they possess, or exchange to mutual advantage as when gold was plentiful. It is claimed that gold is hoarded in bank and Government treasuries. If this was so, the very necessity of the case would cause it to be brought out and used. The real truth is that it is scarce, and becoming more so, and unless new and prolific gold fields are discovered, the present depressed condition of trade will continue until prices adjust themselves to the increased value of gold.

Because the management of our gold and silver mines has too often been unwise and extravagant, and because in the days of our plenty we have disregarded small things, it should not be charged that the business itself is defective. On the contrary, its excellence is proved by its frequent success, even under admitted mismanagement.

Gold mining is a legitimate, honorable, and interesting occupation, and, when properly conducted, as safe as any that can be mentioned. The Government of Victoria, in Australia, already realizes how important to the Colonies and the mother country is the continued production of gold, and has enacted laws to assist the prospectors in discovering and working new gold fields; while California, with less wisdom and foresight, discourages mining. It should be the policy of our State, as of other countries, to turn her vast mineral resources to the best account. Instead of crippling the gold miner, he should be encouraged and afforded special facilities for his work. Instead of treating him as a public enemy, he should be regarded as a useful and important agent in maintaining the wealth of the country. Instead of stopping the work of those who injure without malice a small portion of the agricultural lands of the State, we should rather consider the vast importance of the gold yield, and seek some remedy or formulate some plan, whereby the miner may continue his work and the farmer at the same time be protected.

BIMETALISM.

While it cannot be denied that gold is the king of metals, and that all values are measured directly or indirectly by it, silver and other inferior metals should not be scorned. From present indications California will become a large silver-producing State. Having had a period of gold production, a new era of silver begins to dawn upon us. It is known that at various times in the world's history, after an unusual output of gold, when that metal became scarce some inferior metal was substituted for it. Silver was at first taken for this purpose, but copper, and even iron, were also used for money. To this extent bimetalism is admissible and possible, but any attempt to establish and to long maintain a fixed relative value between any two or more metals, must result in failure.

The idea of sustaining a double standard is an absurdity. The word

standard implies something having a fixed or permanent value. While any one substance may be accepted as the measure of the comparative value of many or all others, if a double standard was possible, it would be equally possible to have a quadruple or multiple standard. There must be one standard, or none.

Any act of Legislature to create and maintain a double standard would be no less ridiculous than the deed of Xerxes, who lashed the Hellespont because it destroyed his bridge, or of Cyrus, who punished the river Gyndes.

So difficult has been the settlement of this question in times past—for it is as old as history—that the Chinese were compelled to substitute copper for gold as a measure of values. The standard, whatever its substance may be, is *fixed* only in name, for it fluctuates in obedience to the universal law of supply and demand; but as a standard it remains stationary, while everything measured by it fluctuates in proportion. This was shown in the case of United States currency during and immediately following the civil war, when paper was created a legal tender and assumed to be a standard. This was a fallacy, for while gold was said to fluctuate, it was in fact the currency that did so. In California, where we had no currency, the price of gold remained as nearly the same as it could, compared with other articles of commerce, and there was no change in the value of gold in other countries.

If it should be thought wise to make silver the standard, values would adjust themselves, and with an increased circulating medium, trade and commerce would prosper or seem to prosper as before. There would be no gold in circulation; if we wanted that metal we should have to buy it as we do any other commodity. Unless other nations also accepted the silver standard, our silver coin would be at a discount in all countries which retained the gold standard.

The acceptance by the United States of a silver standard would be a benefit to our State, for it would stimulate silver mining and lead to the opening of many mines now idle, whatever effect it might eventually have on trade and commerce.

We have the satisfaction of knowing that there are in our State practically inexhaustible reserves of the precious metals, which we can draw upon if we desire. That our people should not fully avail themselves of these advantages seems incredible.

DIFFICULTIES ATTENDING MANUFACTURING IN CALIFORNIA.

Another reason for encouraging mining in California is the difficulty which manufacturers experience in disposing of their products, owing to competition with the East and Europe, and to the small population of the State and Pacific Coast. If the miners cease to be producers they must embark in some other business or leave the State. If the former, there is no avenue open but agriculture, manufactures, or commerce, all of which are already full, not to say overdone. If there is no gold produced for exchange with other centers, it will prove a check to enterprise on this coast. The sudden cessation of the former golden income to our merchants, manufacturers, mechanics, and farmers, cannot but be felt in every department of industry.

Upon agriculture alone the former prosperity of our State cannot at present be maintained. In course of time, when our population becomes larger, and prices have sunk to a level with those in older States; when we form habits of economy, frugality, and providence; when we discover new coal mines, or learn to utilize our petroleum, and all the various resources

of our State, the general prosperity will equal that of others; but now, without gold, we have no special advantage over our sister States, save in climate.

Population of California and the Pacific Coast, as compared with other centers:

California, in 1880	864,694
Oregon	174,768
Washington Territory	75,116
Nevada	62,266
Arizona	40,440
Total Pacific Coast	1,217,284

New York and neighboring cities:

New York	1,206,299
Brooklyn	566,663
Newark	136,508
Jersey City	120,722
Patterson	51,031
Hoboken	30,999
Elizabeth	28,229
Total	2,140,451

It will be seen by the above figures that New York and the cities in its vicinity contain nearly twice as many people as the entire Pacific Coast.

How would New York prosper if it depended solely on its own inhabitants for a market? How can California support large manufactories with so small a market, and against the competition of eastern dealers, who have far greater advantages and facilities, and produce manufactured goods cheaper than we can?

BUILDING STONES AND BUILDING MATERIALS IN CALIFORNIA.

I have had occasion in all my reports to allude to the building materials already found and likely to be found, and the increasing use of them in the State. The subject is of such importance that I cannot refrain from again calling attention to it, to sum up recent discoveries made and to give general information, which I trust will be interesting and instructive to citizens of the State who have not the opportunity or the leisure to study the large number of reference works which treat on this subject.

HISTORY OF BUILDING IN ANCIENT AND MODERN TIMES, WITH SOME ACCOUNT OF THE MATERIALS USED IN CONSTRUCTION.

The question as to what shall replace the perishable structures now so generally built in the State, and especially in the city of San Francisco, is one that should engage the serious and immediate attention of our people.

To those who have not well considered this subject, the solution would seem to be simply the selection of some accessible stone and its immediate use in buildings, but such hasty action might prove an error.

In the history of the world very serious mistakes have been made in the selection of building stones, to the injury of individuals and communities.

There are certain conditions which render stones suitable and durable in one locality, but short-lived and nearly worthless in others.

This was strikingly illustrated in the selection of stone for the construction of the Parliament Houses in London.

In their native beds these stones had withstood climatic influences for centuries, and two fine buildings, Southwell Minster and York Minster, both of the same material, and both many years old, were still in a good state of preservation. But when the same stone was laid in the magnificent walls of the palace, in the smoky, acid, foggy atmosphere of London, decay early commenced, and a system of patching, painting, scraping, and cleaning was found necessary, which has been continued at intervals, to the disappointment and chagrin of the good people of the world's greatest city. The obelisk which stood for thirty centuries, more or less, in the dry atmosphere of Egypt, crumbled in a few years in New York. If it had been set up in Arizona, or on the Colorado Desert of California, and protected from wind-driven sands, its deeply sculptured hieroglyphics would, without much doubt, have remained legible for a thousand years more. The desirable qualities which characterize a really good building stone are: *First*, durability. *Second*, beauty. *Third*, ease with which it can be cut into suitable forms for use. And, *Fourth*, proximity to the cities where the stone is required.

The advantages of stone over other building material may be summed up as follows: beauty, durability, and safety from fire and ordinary earthquakes, the latter an important consideration in California, and one we may not ignore.

In the one item of insurance alone, should fireproof buildings replace those of wood, millions of dollars would be retained in the country, while the cost of the Fire Department system would be reduced to a minimum.

The construction of good buildings gives employment to mechanics and workingmen, who are thereby enabled to support their families, and to live in comfort. Another consideration which is often overlooked is loss of capital employed in the construction of perishable buildings which become worthless in a few years. The rocks most generally used as building material are: *granite*, *syenite*, *porphyry*, *diorite* or *greenstone*, *lavas*, including basalt and trachyte; *freestones* or *sandstones*, and *limestones*, including tufa, travertine, and dolomite, *slates*, *serpentines*, etc.; all these are found in California and most of them are abundant.

The crust of the earth, as far as known to man, is composed principally of seven minerals, to the extent of nineteen twentieths, as follows:

1. Quartz.
2. Talc or steatite.
3. Serpentine.
4. Hornblende and augite (varieties of pyroxene).
5. Feldspar, several varieties.
6. Mica.
7. Carbonate of lime.

When two or more minerals are mechanically mixed they form *rocks*, as generally understood. Some minerals occur in such large masses that they also are classified as rocks. The crystalline rocks as granite, syenite, gneiss, etc., are complex, and contain nearly, if not all the elements which enter into the composition of volcanic, plutonic, sedimentary, and metamorphic rocks, including the metals, gold, silver, lead, tin, iron, etc.

They decompose to sand, kaolin, and alkalies, which form new combinations in soils and minerals. Sandstones, shales, slates, mica schists,

and argillaceous rocks, are built up of the ruins of older crystalline rocks, and, if we are not mistaken, return to their former condition and become crystalline rocks again.

In California building stones abound. It was a wise remark made by some writer unknown to me, but frequently quoted, that "Time seldom spares what it does not take time to create." This aptly applies to the art of building, an art greatly conducive to the comfort, prosperity, and happiness of mankind.

Wood was extensively employed in building ancient cities. These temporary houses were replaced first by brick, and then by those constructed of marble and other building stones. Wood was largely used in Rome. Up to the time of Augustus brick was the common building material, but the upper part of the better class of dwelling houses still continued to be of wood. From the reign of Augustus better materials were generally introduced, and after the great fire in Nero's time, a volcanic rock now called "peperino" came into quite common use. Nero did not allow the wooden upper structures to be renewed, and made the streets wider and straighter. Peperino is a volcanic ash, cemented by carbonate of lime or silica. It is very light, and for that reason suitable for a certain class of buildings. It was extensively used in the ancient cities of Herculaneum and Pompeii. This rock, or one of a similar character, is abundant in California.

Specimens from ancient Rome may be seen in the State Museum, numbered 6437, and others.

During the splendor of the Empire magnificent and costly buildings, both public and private, were erected in Rome; each Emperor vieing with his predecessor in their construction. After the time of Augustus, the then known world was ransacked for new and elegant marble. It was early discovered that certain volcanic tufas or ash, called Pozzuolana, when mixed with the proper proportion of lime, became a hard and durable cement.

The discovery of the cementing properties of this material seems to have been accidental. At Baiæ, on the coast of Italy—which was a celebrated watering place and resort of the wealthy Romans in ancient times—it was thought desirable to increase the coolness of the situation by building the summer villas on masonry, extending beyond the shore, and surrounded by the waters of the bay. In experiments for this purpose, made with different cements or mortar, a kind of earth now known to be of volcanic origin, was discovered at Puteoli, to which the name of Pulvis Puteolanus was given, afterwards corrupted to Pozzuolana, by which it is still known.

It is claimed by historians, that to the discovery of this cement, Rome owes, in great measure, the massive and stately character of her public works and buildings, and that without it, the magnificent bridges, aqueducts, and roads, would ere this have fallen into decay.

California is known to be rich in volcanic materials, and it is not unlikely that Pozzuolana may yet be found among them. Such a discovery by the State Mining Bureau would be worth more to California than the whole cost of the institution since its inception. The fact that our State is specially subject to earthquakes, must be admitted. It is also known that it is possible to construct buildings that will resist all but the most violent shocks. Since the weakest part of modern buildings is the cement or mortar with which they are put together, it is evident we must improve the quality of that, in order to insure their durability. It has been observed in many old Roman structures, that the mortar outlasts the stones themselves, and that where the latter have been worn away by the

influence of time, the cement, in some cases, actually projects from their surface.

A tufaceous limestone or travertine of a pale straw color was found in extensive quarries near Tivoli, a few miles from Rome, which proved to be a durable and beautiful building stone. This became the principal building material of the ancient and modern city. It was selected by the Emperor Augustus, and soon a style of building which combined travertine with Carrara marble became very popular. The first great public building of this material was the Colosseum, which was finished by Vespasian and Titus. After it fell into ruin, it became a convenient quarry from which stones were selected to put into more modern buildings, and it is intimated that even Michael Angelo was guilty of this vandalism.

In more modern Rome the following well known buildings and many others of lesser note, are built of travertine: *St. Peter's*, the *Museum and Church of Lateran*, the *Castle of St. Angelo*, and the *Quirinal.*

Travertine had the convenient property of being soft when first taken from the quarry, and could be cut with a common saw, but it hardened with time. Specimens of pozzuolano and travertine also find a place in the State Museum. In ancient Greece marbles were also extensively used; in Egypt granite, syenite, and porphyry; in Babylon, sun-dried brick and asphaltum.

Many of the ruins of ancient cities show that architecture had reached a point, even in very ancient times, as near to perfection as anything human can. It is admitted that the moderns have never equaled the ancients, and at the present time our best architects are content to imitate them.

Marble is generally understood to be *carbonate of lime*, either white or colored, uniform or variegated, and pleasing to the eye; the term is also applied to any colored stone soft enough to easily cut, and hard enough to bear a good polish. Under the latter meaning may be classed the following minerals and rocks: dolomite, serpentine, verde antique, steatite, ophite, and even diorite, and porphyry; *Inyo marble*, so called, is dolomite.

Webster gives the following definition of marble: "Any species of calcareous stone or mineral of compact texture, and of a beautiful appearance, susceptible of a good polish; any firm limestone, fitted when polished or otherwise for ornamental use. Also other rocks of nearly the same hardness, capable of the same uses, as serpentine; but improperly, polished slabs of harder rocks, as porphyry, granite, and the like."

The name is derived from a Greek word, to *sparkle* or *flash.*

True marble is *carbonate of lime*, composed of carbonic acid and the oxide of calcium, or lime, in the following proportions:

Carbonic acid	44
Lime	56
	100

Edward Clarke, who traveled in Europe in the year 1800 and after, came to the conclusion, from his large experience and observation, that Parian marble was the most enduring of stones used in ancient sculpture and architecture; but Geike, the English geologist, informs us that inscriptions on marble tombstones, in large towns where coal smoke and rain are abundant, become illegible in fifty years. Crystalline limestone has been formed artificially by heating chalk or lithographic stone, which seems to prove that marbles are metamorphic. The accounts given by travelers and historians concerning the art works of the ancients, are almost incredible. Clarke describes in pleasing detail the architectural ruins met with by him in the Crimea, in Greece, and on the plain of Troy; Volney has written in the

most charming language of the ruins of Palmyra; and Pliny informs us that the art of cutting marble into slabs dates back to the building of the palace of Mausolus at Halicarnassus. The walls of that celebrated building, one of the seven wonders of the world, were of brick, covered with Cyzican marble from Proconnesus.

This art was introduced into Rome, and the described mode of cutting, by the use of strips of iron and sand, does not materially differ from that practiced at the present day.

The same author states that marble began to be used in public buildings in Rome in the Ædileship of M. Sacurus. His theater, described by Pliny as "the greatest that has ever been made by the hands of man," was three stories high. The lower was of marble, supported by three hundred and sixty columns of the same material; the second of glass, and the highest of gilded wood. This building was planned to seat eighty thousand spectators. After this period there was a rivalry as to who should erect the most costly and grand public buildings; interior walls were not only covered with the most costly imported marbles, but the stone was richly sculptured, and even in part painted or gilded. In the time of Nero, a method of inserting spots, or ornamental patches of other marbles, was invented—a sort of Mosaic or inlaid work, very costly and unnatural, but nevertheless much admired.

Then followed a general mania for marbles and rare ornamental stones, which were introduced into private as well as public buildings, and which were sought in every part of the known world.

The first private citizen who covered the entire walls of his house in Rome was Mamurra, who was only satisfied with the costly and rare marble of Carystus and Luna, the modern Carrara. M. Lepidus made the lintels of his house of Numidian marble (Giallo Antico), in the year of Rome 676. A few years later columns of foreign marble were first erected in Rome by L. Crassus, the orator; his house on the Palatine Hill was remarkable for its magnificence. The columns were six in number, and twelve feet in height; they were of Hymettian marble (Carrara).

L. Lucullus, when Consul, introduced into Rome a black marble, which was found on the island of Melos, and named Lucullan marble after him. We are indebted to Pliny for this information.

The following is a list of the rarer and most noted of ancient marbles:

White: Parian, Pentellic, Luna.
Black: Lucullan, Nero Antico.
Red: Rosso Antico, Cottonello.
Green: Verde Antico.
Variegated: Lumachella, Phrygian, Oriental Alabaster or Onyx.

The Parian and Pentellic marbles were pure white, and were considered better than those of Carrara. They are nearly pure carbonate of lime. Parian was found on the Island of Paros, one of the Grecian Archipelago. It could be distinguished by a peculiar luster on the freshly broken surface. The quarries from which this fine marble was obtained are very ancient. Pentellic marble was from Mount Pentellicus, in Attica, ten miles only from Athens. The Parthenon, in that ancient city, was constructed of this stone. Being completed in 438 B. C., it has resisted the destroying hand of time for two thousand three hundred and twenty-four years. Phidias, born four hundred and ninety years B. C., and Praxitales, celebrated Grecian sculptors, both worked on this, the most magnificent of ancient or modern buildings. The Pentellic quarries have been lately reopened.

Luna or Carrara marble is also nearly pure carbonate of lime (98.1 per cent), the usual impurities are clay, pyrites, and quartz. The marble often contains imbedded crystals of quartz, perfectly transparent and doubly terminated, called "Cararra diamonds." There are a number of varieties of this marble, but the best has a delicate waxy luster which is much admired; there are many fine specimens in the State Museum. The quarries of Carrara are supposed to have been opened by the Romans one hundred years B. C.; they were worked in the time of Julius Cæsar, and more extensively in the time of Augustus, who was called by Livy "the builder and restorer of all the temples." The ancient Etruscan seaport of Luna, eight miles from Carrara, described by Pliny as a "noble harbor," is now more than a mile and a half inland, with meadows extending to the shore. Marble was largely used in the construction of this city; large blocks still remain which are supposed to have been the seawall, from a large metal ring found attached to one of them. During the dark ages, Luna having then fallen into decay, was robbed of its marble blocks and columns, which were sent to construct buildings elsewhere. The marble for the Pantheon at Rome was brought from Carrara; this building was erected by Agrippa twenty-six years B. C., and is still in a good state of preservation. The palace and arch in the Via Domizi, and the baths of Caracalla are of Carrara marble. Lucullan black marble was supposed to have been brought from Meroe in Abyssinia; it sometimes showed small spots and veining of white, but the best quality was pure black. A California marble, recently found near Colfax, and numbered 2799 in the State Museum Catalogue, answers very nearly to the description of the Lucullan marble. The "Nero Antico" was also a black marble, said to have been found in Laconia; it was fine-grained and compact, sometimes showing delicate veining of white.

Fragments of "Rosso Antico" marble are frequently found in the ruins of ancient Rome. The locality of the quarry is unknown, but a similar, if not the same, marble has recently been found at Skautari, a village in Greece. It is of a deep blood red color, sometimes inclining to purple, and even rose color; and sometimes clouded with white, black, or purple lines. A fine specimen from ancient Rome may be seen in the State Museum, numbered 6020. This marble was much admired and prized by the ancients. A marble of beautiful rose color has been found in California; it is numbered 5344 in the Catalogue of the State Museum, and is nearly identical with "Rosso Antico." Very little is yet known of its occurrence, but it is likely to be valuable and important. A description has been given elsewhere.

Cottonello marble was found near a town of the same name a short distance north of Rome. It was of many shades of red, but of inferior quality, although somewhat extensively used.

"Verde Antico," or as it is now called in English, "Verde Antique," is not a true marble, but is serpentine combined with carbonate of lime or magnesia. It was much prized by the ancients, and is still extensively used. The color is due to oxide of chrome, and as chromic iron and serpentine are both common and abundant in California, there is reason to hope that this beautiful ornamental stone may yet be found in the State. There are many fine specimens of "Verde Antico" from Italy in the State Museum.

"Giallo Antico" was considered one of the most valuable and beautiful of the ancient marbles. The grain was very fine, and the coloring beautiful and rich. It resembled the Sienna and Verona marbles, but exceeded them in beauty and texture. It was first found in Numidia, in Northern Africa, and for that reason sometimes called "Numidian marble." It

received a high polish. The base or keynote color was yellow of many shades, from the deepest to nearly white or pale straw color. Some varieties were brecciated, and others veined or mottled.

There are a number of examples of this marble still to be seen in Rome; columns at the Pantheon, the Arch of Constantine, and two columns at the Vatican. An ancient quarry has lately been discovered in Algiers, which is supposed to be that worked by the Romans, and afterwards abandoned and lost.

A beautiful yellow brecciated marble has been found at Tehachapi in Kern County, California, which resembles some of the described varieties of "Giallo Antico." It is certainly very beautiful. It is numbered 710 in the State Museum Catalogue. Another mention of this beautiful marble is made elsewhere.

Sienna marble, found near Volterra, is from cream color to dark yellow, sometimes veined with white, and even black. It is much employed at the present time, and is a durable and beautiful ornamental stone.

Nummulitic, or Verona marble, is in color from cream to nearly white. It was much used in ancient and mediæval buildings; the Roman amphitheater of Diocletian was built of it. It was extensively used in Venice; the porch and interior columns of the cathedral of Verona are fine examples.

Lumachello, or "fire marble," owes its wonderful brilliancy and play of colors to imbedded shells; it is now found at Bleiberg in Carinthia.

The Phrygian marble was very rare and costly; the ground color was creamy white, with veins of dark red, sometimes pink, or yellow. From its fancied resemblance to the plumage of the peacock, it was sometimes called "Pavonazetta." The Emperor Hadrian was very fond of it, and it was used in the construction of his tomb. The temples of Juno and Jupiter had one hundred and twenty columns, and a pillar of it was found in the ruins of Pompeii.

Oriental alabaster or onyx marble was held in high esteem by the ancients a thousand years or more ago. The quarries were lost, and for a long time remained unknown, until rediscovered in Egypt in 1849, by M. Delmonte, a French traveler. The marble of the same nature found in California and known as "Suisun marble," and "California onyx," is more beautiful in some of its varieties than the ancient, and it has gained a world wide reputation for beauty. In the fourth annual report of this office, on folio 72, this beautiful ornamental stone has been described, and the principal locality given. Attention has only lately been called to the marbles of our State, and while few fine varieties are known, many more will doubtless be found. There is reason to believe that there will soon be an awakening in our State and principal cities to the importance of this subject, and in time our mountains, now so celebrated for the vast quantities of gold they have given to the world, will be searched over for building materials, and the fortunate person who discovers a quarry of good building stone or marble, will be more sure of a fortune than the gold seeker who now prospects the heights for the precious metals. In anticipation of this, new localities have been recorded in these reports, and discoveries already made. It will be seen that during the few years of the duration of the State Mining Bureau, that something has been accomplished in this direction.

TECHNICAL DESCRIPTION OF THE RED MARBLE (ROSEO ANTICO), FOUND IN AMADOR COUNTY, MENTIONED ABOVE.

Color, blood red, with mottlings of a slightly different shade, and an occasional vein of pure white. Specific gravity, 2.828; hardness, 3. By

qualitative analysis it was found to contain *lime*, *carbonic acid*, *oxide of iron*, and *silica*.

It dissolves with violent effervescence in hot hydrochloric acid, leaving a small red insoluble residue. The filtrate was golden yellow; ammonia threw down a heavy precipitate, leaving a transparent and colorless liquid, in which oxalate of ammonia caused a heavy precipitate of lime. This filtered off, phosphate of soda gave no precipitate, but the filtrate became slightly opalescent.

A few fragments of the marble, heated to redness in a platinum crucible, lost 14 per cent by weight. The residue was nearly white. It slaked and became hot on addition of water, but still contained carbonic acid, and effervesced slightly with hydrochloric acid. When dissolved and the residue dried on a water bath, a considerable portion was found to be magnetic. The non-magnetic portion looked, when seen under the microscope, like selenite, or more like brucite.

A sample treated in powder with cold diluted hydrochloric acid, left a large red residue, 9.4 per cent, and the solution was colorless. The red residue was partly soluble in boiling hydrochloric acid. Fused with alkaline carbonates it became decomposed, and was then soluble in hydrochloric acid, leaving a residue of silica, equal to 3.74 of the marble. The solution containing sesqui-chloride of iron was golden yellow; ammonia precipitated all the iron, leaving the solution colorless.

The yellow brecciated Tehachapi marble, from Kern County; the California giallo antico, mentioned above, was also examined chemically. It effervesced with acids and was nearly all soluble, the insoluble portion being only 1.6 per cent. From the solution carbonate of soda threw down a precipitate weighing 92 per cent.

Mr. Israel Luce, of Sacramento, called April 20, 1886, at the State Mining Bureau, and gave the following information regarding the locality of this marble.

The deposit is a large one, and is situated half a mile from the town of Tehachapi, on the road to Caliente. At that distance, on a flat on which there are springs of water, stands a small house. Less than a quarter of a mile from the house, up the hill, by an old wagon road, the excavations may be seen, and some large blocks lie quarried out. Mr. Luce says that some of the marble is of a pure yellow color and very beautiful.

TEHACHAPI MARBLE (not Giallo Antico).

Mr. W. G. Campbell called April 23, 1886, at the State Mining Bureau and informed me that the so called *Tehachapi marble* is found nine miles west of the town of Tehachapi, in Bright's Valley. It is found in large quantities, and there is a large block at the railroad station at Tehachapi. The marble is fine grained and beautifully mottled, resembling specimen No. 5860 of the museum catalogue.

The beautiful recently discovered Humboldt marble is found on the lumber claim of Flanegan & Brosman, seven miles from Eureka. This is all the information this office has concerning it.

DOLOMITE.

Dolomite is a double carbonate of lime and magnesia, sometimes in chemical equivalents, sometimes in mechanical mixture. It is called by many names, as dolomite, magnesian limestone, bitter spar, magnesian spar,

pearl spar, brown spar, compound spar, rhomb spar, muricalcite, picrite, tharandite, miemite, conite, gurhofian, and, lastly, Inyo marble.

It is considered true dolomite when in chemical proportions, otherwise magnesian limestone. Its hardness is from 3–5 to 4; specific gravity, 2–9; weight of cubic foot, about 180 pounds; luster, from vitreous to earthy; color, white, various shades of rose red, gray, brown, green, or nearly black. The composition is so varied that no single analysis would convey a correct idea; when expressed by the formula, $Ca\ O,\ CO_2 + MgO\ CO_2$, it contains—

Carbonate of lime	54.35
Carbonate of magnesia	45.65
	100.00

In Klaproth's Chemical Mineralogy, published in English in 1801, may be found detailed analyses of two specimens, one from Sweden, and the other from the Tyrol, since which time very many analyses have been made and published. Before 1791 dolomite was confounded with the limestones, until the celebrated French chemist and mineralogist, Dolomieu, called attention to it. He first noticed it among the remains of ancient sculpture in Rome. In a paper to the Journal of Physics, he described it under the name of "A calcareous stone which effervesces but little with the acids." Saussure, a Swiss naturalist, found it in place in the Alps, and named it after the original discoverer "dolomie." The present name, "dolomite," was given to it in 1794 by Kirwan, an Irish chemist and mineralogist.

Dolomite was originally a sedimentary rock; this is proved by the fossils it often contains. There are several theories as to its formation, but the chemistry of its genesis is admitted to be very imperfectly understood. One theory is that it was formed in the beds of large lagoons, which became inland seas by being cut off from the ocean by some geological change in the earth's surface. As the confined water slowly evaporated, it dropped its lime, its salt, and lastly its magnesia, forming beds of dolomite. This theory is supported by the fact that beds of clay, gypsum, and rock salt are frequently found associated with dolomite. Another theory is that it was originally a precipitate let fall from the primitive sea by supersaturation, as thinolite is now being and has been formed in the alkaline lakes of the Great Basin of California, Nevada, and Utah. Still another theory assumes that the deposit was originally limestone, formed at the bottom of an ancient ocean, and that metamorphism has taken place by the addition of carbonate of magnesia from concentrated sea water, or by the abstraction of a portion of the lime by the action of water holding carbonic acid from a mineral or rock already containing a notable quantity of carbonate of magnesia. Dolomite has been formed artificially in several instances. Once in a glass flask containing a mineral water, which held bi-carbonate of lime and magnesia in considerable quantity, crystals of dolomite formed from two to three millimeters long.

Morlot produced dolomite crystals by heating carbonate of lime with solution of sulphate of magnesia in a closed tube.

Durocher subjected fragments of porous limestone in a bed of chloride of magnesium for three hours in a gun barrel kept at a red heat. Dolomite crystals formed which were stained yellow by iron. Other successful experiments of a similar nature have been recorded.

Dolomite has been used in sculpture, in architecture, and for making lime and cement. In the United States lime made of it is held in esteem,

but in England it is considered of bad quality, and is not much used. Magnesian limestones burn more easily, slake more slowly, and do not set so quickly as other limestones. As a building stone dolomite ranks among the best, but there are many different qualities, some of which are inferior to others. It is one of the chief building stones of the north of England, where a silicious dolomite is used in paving and building which gives perfect satisfaction. A yellow dolomite was used for the front of the Museum of Practical Geology in London, and the Parliament houses are built of it; but it has been shown that this stone was a failure. The commission of geologists and scientific men appointed to select a suitable stone for these buildings decided that crystalline dolomite was the best and most durable in proportion as the composition approached a mixture in chemical equivalents.

Dolomite was much used by ancient sculptors. The Apollo Belvidere, the greatest existing work of ancient art, is of dolomite. It was so called because placed in the belvidere of the Vatican. It represents the deity at the moment of his conquest of the python. The statue was found in the ruins of ancient Antium in 1503, and placed in the Vatican by Pope Julius II. Many other statues and works of art are of dolomite.

The so called Inyo marble has been selected for the building material to be used in the construction of the Sharon Gate at Golden Gate Park, and of which I am quite sure the people of San Francisco and California will be proud. It is my opinion that no use of the generous bequest could be more appropriate, or more likely to give general satisfaction, and I am fortunate in knowing by actual observation something concerning this now much-talked-of "Inyo marble."

As early as 1862 I traveled from the south side of Mono Lake to the head of Owen's Valley, then without a house or a settler north of Camp Independence. From Adobe Meadows our party of four saw for the first time the grand summit of White Mountain, capped with what seemed to be snow, slightly yellow in tint, which we attributed to the golden light of the setting sun, or dusty particles blown upon it from the desert adjacent; but snow it certainly appeared to be. When, however, we reached the base of the mountain, I discovered that the apparently snowy summit was in reality composed of a white rock; and in the rugged cañons we picked up fragments which, when freshly broken, were as pure and white as the finest Carrara marble. Subsequent chemical examination proved it to be dolomite of the finest quality. This was the now celebrated Inyo marble, which is found in numerous localities in the Inyo Range, from White Mountain south one hundred miles or more. While we make special mention here of Inyo marble, we must not for that reason omit to state that other beautiful marbles and building stones are found in those mountains, which I have seen and examined with great interest.

The most beautiful porphyries, equal to those of Egypt, are of frequent occurrence, while granite, syenite, pegmatite, and various crystalline and metamorphic rocks are met with in the sublime cañons, or lie tilted against the flanks of the higher mountains.

TECHNICAL DESCRIPTION OF INYO MARBLE.

Color, pure white, saccharoidal, cryptocrystalline, hardness between 3 and 4, scratches calc-spar with ease, specific gravity 2,856, which being the case a cubic foot will weigh 178.5 pounds avoirdupois. While in mass the mineral is resistant to crushing force, a small fragment can be crumbled between the fingers to a crystalline powder, which under the micro-

scope may be seen to be obscure crystals with concave faces; some four sided pyramidal terminations are more distinct. At a red heat continued for two hours, the mineral loses 30.3 per cent by weight; the calcined mineral when wet with water becomes very hot and falls to a powder. In cold concentrated hydrochloric acid the mineral even when pulverized effervesces but feebly, but on application of heat the action is intensified, and a perfect solution is obtained which is golden yellow when concentrated, and pale straw color when dilute. The hydrochloric acid solution becomes darker colored on addition of nitric acid, and solution of sulphocyanide of potassium imparts a deep blood red color to it. From the first solution ammonia throws down a small precipitate; the filtrate from this precipitate is colorless. Oxalate of ammonia throws down a copious precipitate; this being filtered off, phosphate of soda gives a second and also copious white precipitate. The mineral does not absorb water to any considerable extent; a fragment weighing 39.71 grains, soaked in water for twenty-four hours, increased in weight only 79 milligrams.

Before the blowpipe on charcoal the mineral falls to a powder like aragonite. This is owing to the fact revealed by the microscope that it consists of crystals distinct in themselves held together by a feeble force. In a closed glass tube the mineral gives traces only of water. These reactions show the presence of the following substances: Carbonic acid, lime, magnesia, iron, alumina. The two latter in small quantities, and traces of water. A full qualitive and quantitive analysis will be made in the future.

Measurements of the crystals, average of ten, in decimals of an inch:

Smallest	0— 00082 +
Largest	0— 02853 +
Average	0— 01472 +

Mr. Israel Luce, a marble cutter of Sacramento, has given the following information as to the quarry from which the Inyo marble is to be taken to build the Sharon gate to the park: It lies a few miles from Keeler and near the lake. The exact locality is the southwest quarter of section fourteen, township sixteen south, and range thirty-seven east. It is owned by the Inyo Marble Company, incorporated last September in the State of Nevada.

A variety of dolomite has been found cropping on the Contra Costa hills, not far from the State University. When found it was said to be pozzuolana. An analysis made by Professor Rising, of the State University, gave the following result:

Lime	24.52
Magnesia	17.48
Carbonic acid	38.48
Alumina and iron	3.13
Silica	14.55
Water	2.09
	100.25

The rock has not been sufficiently developed to prove its quantity.

THE FOLLOWING ARE LOCALITIES

Of the principal rocks, building stones, and building materials collected by the State Mining Bureau:

1. AGALMATOLITE (?), somewhat resembling the Chinese figure stone. This beautiful ornamental stone is found two miles west of Greenwood, El Dorado County, in a vein from six inches to a foot in thickness.
2. BASALT, plains between Oroville and Pence, Butte County.
3. BASALT. Used for street pavement. Mt. Pisgah quarries, one mile south of Petaluma, Sonoma County.
4. FINE GRAINED DIORITE OR BASALT, Folsom, Sacramento County. Strongly resembling serpentine externally.
5. BUILDING STONE, Mr. Wheat's house, Double Springs, Calaveras County.
6. DIORITE, wall rock of the Clipper Gap Iron Mine, Placer County.
7. DIORITE, near the bridge, section fifteen, township eighteen north, range thirteen east, Mount Diablo meridian, Placer County.
8. DIORITE, township thirteen north, range eight east, Mount Diablo meridian, Placer County.
9. DIORITE, iron mines near Clipper Gap, section twenty-four, township thirteen north, range eight east, Placer County.
10. DIORITE, wall of furnace building, Clipper Gap Iron Mines, Placer County.
11. DIORITE, fine grained, Mineral Hill District, Mono County. It contains considerable finely divided magnetite.
12. DIORITE, fine grained, in which magnetite is replaced by pyrites, Mineral Hill, Mono County.
13. DIORITE, croppings near Cave City, Calaveras County.
14. DOLERITE, east wall, Comanche Mine, Mono County.
15. DOLOMITE, Modoc Mine, Inyo County.
16. DOLOMITE, Guadalupe Quicksilver Mine, Santa Clara County.
17. DOLOMITE (resembling fossil coral), Morro, San Luis Obispo County.
18. DOLOMITE, Deep Spring Valley, Inyo County.
19. DOLOMITE, white, Amargosa Wash, San Bernardino County.
20. DOLOMITE, Inyo County.
21. DOLOMITE, white, Tujunga Cañon, seven miles from San Fernando, San Gabriel Mountains, Los Angeles County; valuable for building and manufacturing purposes.
22. DOLOMITE (impure), found near the State University, Berkeley, Contra Costa County; mistaken for pozzuolana.
23. FOSSILIFEROUS ROCK, near Soledad, San Diego County.
24. GARNET ROCK, Calpella, Mendocino County. A large cropping.
25. GLAUCOPHANE ROCK, wall rock of the Collier Mine, six miles northeast from Murphy's, Calaveras County.
26. GNEISS, brought to San Francisco on river schooners and used for street pavements.
27. GNEISS, said to be found in San Francisco in place.
28. COARSE GRANITE, near Sacramento.
29. GRANITE, Newcastle, Placer County.
30. GRANITE, Folsom, Sacramento County.
31. GRANITE, Rocklin, Placer County.
32. GRANITE, Yosemite Valley, Mariposa County.
33. GRANITE, Mariposa Mine, Mariposa County.

34. GRANITE, Crystal Lake, Summit Valley, Nevada County.
35. GRANITE (micaceous), near Penryn, Placer County.
36. GRAVEL, San Pablo, Contra Costa County.
37. GRAVEL, distinct from the sandstone; used in macadamizing streets, Los Angeles.
38. HORNBLENDE ROCK, Santa Barbara Mountains.
39. HORNBLENDE ROCK, Healdsburg, Sonoma County.
40. HORNBLENDE ROCK, Folsom, Sacramento County.
41. HORNBLENDE ROCK, Gold Run, Placer County.
42. LAVA, Mendocino County.
43. LAVA, Napa County.
44. LAVA, compact, near St. Helena, Napa County.
45. LAVA, basaltic, near Calistoga, Napa County.
46. LAVA, red, Butte Mountain, near Jackson, Amador County.
47. LAVA, near Santa Rosa, Sonoma County.
48. LAVA, trachytic (?), which caps isolated hills between Milton and San Andreas, Calaveras County.
49. LAVA, brecciated, found in immense cliffs, Little Shasta River, Shasta County.
50. LAVA, basaltic, showing a scale, which is due to oxidation of iron to limonite, near Doon's Mill, Butte County.
51. LAVA, white (so called), indurated volcanic ash, near Murphy's, Calaveras County.
52. LAVA, which exists in immense quantities on the borders of Mono Lake, Mono County. Owens River cuts through this formation in a deep cañon. It is easily decomposed, and supposed to yield the soda salts so abundant in that region. It crops out also at Adobe Meadows, in Mono County.
53. LAVA, white (so called), probably indurated volcanic ash, Southern Pacific Railroad, Los Angeles County.
54. LAVA, and pumice, Alviso, Santa Clara County. The Guadalupe River winds through a chain of volcanic vents. They rise but a few feet above the valley.
55. LAVA, cellular, with zeolite, Soledad Cañon, Los Angeles County.
56. LAVA, cellular, Captain Jack's Cave, Modoc Lava Beds, Modoc County.
57. LIMESTONE, calcite, Santa Cruz.
58. LIMESTONE, San Bernardino County.
59. LIMESTONE, tufaceous (thinolite?), Lassen County, section thirty, township thirty north, range fourteen west.
60. LIMESTONE (marble), Clipper Gap Lime Quarry, section thirty, township thirteen north, range nine east, Mount Diablo meridian, Placer County.
61. LIMESTONE (marble), Cave Valley, near Auburn, Placer County.
62. LIMESTONE (hydraulic?), found at the residence of Captain J. M. McDonald, San Francisco.
63. LIMESTONE (fossiliferous), Almaden Consolidated Quicksilver Mining Company, southwest quarter section thirty-four, township twenty-six south, range ten east, San Luis Obispo County; elevation fifteen hundred feet.
64. LIMESTONE, Bridgeport, Mono County.
65. LIMESTONE, Tres Pinos, San Benito County, fifteen miles east of the town.
66. LIMESTONE, Modoc Mine, Inyo County.

67. LIMESTONE, arenaceous, found in the bed of the river, near Yreka, Siskiyou County.

68. LIMESTONE OR MARBLE, blue, with veins of white, Pence, Butte County. It is soluble in hydrochloric acid with effervescence, leaving a small hepatic residue—when struck with a hammer it emits a feted odor—anthraconite—burns to a pure white lime, which slakes perfectly. This stone is well adapted for building purposes, as a useful and ornamental stone. Valuable, also, for manufacturing purposes.

69. LIMESTONE, Posa Creek, foothills of the Sierra Nevada, Kern County.

70. LIMESTONE, near Auburn, Placer County.

71. LIMESTONE, silicious, with what seems to be graphite or molybdenite in small scales, Kern County.

72. LIMESTONE (marble), Bitterwater Ranch, San Benito County.

73. LITHOGRAPHIC STONE, Kern County.

74. MAGNESITE (carbonate of magnesia), Tulare County.

75. MAGNESITE, Damascus, Placer County. Large quantities of this mineral at the locality.

76. MARBLE, white, fifteen miles from Monterey.

77. MARBLE, near Angel's Camp, Calaveras County.

78. MARBLE, Bear Creek, three miles from Colfax, Nevada County.

79. MARBLE, Abby's Ferry, Tuolumne County.

80. MARBLE, Giallo Antico, Tehachapi, Kern County.

81. MARBLE, white, Tuolumne County.

82. MARBLE, white, section fifteen, township thirteen north, range eight east, Mount Diablo meridian, Placer County. This marble has been used in San Francisco for the generation of carbonic acid in the manufacture of mineral waters. It is used also as a flux in iron smelting.

83. MARBLE, white, Tehachapi, Kern County.

84. MARBLE, black, near Central Pacific Railroad, two miles above Colfax, at the lower end of the high trestle, Placer County.

85. MARBLE, half a mile from the railroad depot, Auburn, Placer County.

86. MARBLE, from the Cave, at Cave City, Calaveras County.

87. MARBLE, bed of the Tuolumne River, Tuolumne County.

88. MARBLE, white, nine miles north of Ione, Amador County.

89. MARBLE, red, a beautiful ornamental stone, bearing a good polish, Amador County.

90. MARBLE, fine white, slightly bluish green, suitable for building stone and lime, Inyo County, near C. & C. R. R.

91. METAMORPHIC SLATE, which accompanies the quartz vein, Soulsby Mine, Tuolumne County.

92. METAMORPHIC SLATE, with quartz attached, Soulsby Mine, Tuolumne County.

93. MICA SCHIST, Gold Lake, Plumas County.

94. MICA SCHIST, Ivawatt District, San Bernardino County.

95. MICA SCHIST, Berkeley Hills, Alameda County.

96. PORPHYRY, foot wall Standard Mine, Bodie District, Mono County.

97. PORPHYRY, Bodie Mine, Bodie Mining District, Mono County.

98. PORPHYRITIC DIORITE, Clipper Gap, Placer County.

99. PORPHYRY, red, eight or nine miles from Mesquite Station, San Diego County.

100. PORPHYRY BEDROCK, Malakoff Mine, North Bloomfield, Nevado County.

101. PORPHYRY, Polar Star Mine, Dutch Flat, Placer County.

102. PORPHYRY (probably diorite), Placer County. Said to be found in large quantities. A very beautiful building and ornamental stone, equal to the finest porphyries of Egypt and Europe.
103. PORPHYRY, seventy-five feet thick, Bodie Mine, Mono County.
104. PUMICE STONE, near Mammoth City, Mono County.
105. PUMICE STONE, near Dos Palmos, San Diego County.
106. ROCK RESEMBLING HALLEFLINTA, Fruit Vale, Alameda County.
107. ROCK RESEMBLING HALLEFLINTA, Spanish Ranch, Plumas County.
108. SAND ROCK, with chalcedony, ten miles west of Havilah, Kern County.
109. SANDSTONE, near San José, Santa Clara County.
110. SANDSTONE, eighteen feet thick, Tuolumne County.
111. SANDSTONE, Saucelito, Marin County.
112. SANDSTONE, Glenn Mills, San Mateo County.
113. SANDSTONE, eight miles west of Napa City, Napa County.
114. SANDSTONE, suitable for building stone, Eureka, Humboldt County.
115. SANDSTONE (stained red), Santa Margarita Ranch, San Diego County, near San Luis Rey.
116. SANDSTONE, Glenn Mills, San Mateo County.
117. SANDSTONE, west side of Great Eastern Quicksilver Mine, Sonoma County, supposed to be the footwall.
118. SANDSTONE (coarse grained), Coal Mine, San Benito County, township nineteen south, range eleven east.
119. SANDSTONE (fine grained), Coal Mine, San Benito County, township nineteen south, range eleven east.
120. SANDSTONE, Seal Rock, off Point St. George, northwest boundary of California.
121. SANDSTONE, fossiliferous, near Shasta.
122. SANDSTONE, variegated, near Buchanan Copper Mine, Fresno County.
123. SANDSTONE, feldspathic, sedimentary rock, composed of feldspar, quartz mica, and hornblende, Telegraph Hill, San Francisco.
124. SANDSTONE, Pescadero, San Mateo County.
125. SCORIA, Point San Pedro, San Mateo County, eighteen miles south of San Francisco.
126. SCHIST with garnets, mouth of Russian River, Sonoma County.
127. SCHIST, with impressions of fossil plants, found in the lignite near Vacaville, Solano County.
128. SEDIMENTARY DEPOSIT, Chalk Bluffs, near surface, containing impressions of fossil leaves.
129. SEDIMENTARY MATTER, North Bloomfield Mine, Nevada County.
130. SEDIMENTARY DEPOSIT, found in digging a well, at a depth of seventy-five feet, near Roseville Station, Placer County.
131. SEDIMENTARY ROCK, San Francisco.
132. SEDIMENTARY ROCK, Cliff House, San Francisco.
133. SEDIMENTARY ROCK, Oil Creek, San Luis Obispo County, found in slabs from two to eight inches thick, and from one to three feet wide.
134. SEDIMENTARY DEPOSIT, resembling diatomaceous earth, twelve miles east of Santa Rosa, Sonoma County.
135. SERPENTINE, Bear Valley, Mariposa County.

136. SERPENTINE, Key's Tunnel, California Mine, Yolo County.

137. SERPENTINE, three hundred yards northeast of Pine Tree Mine, Bear Valley, Mariposa County.

138. SERPENTINE, transformation from gabbro, Peninsula of San Francisco.

139. SERPENTINE, Fort Point, San Francisco.

140. SERPENTINE, Yuba County.

141. SERPENTINE, Market and Guerrero Streets, San Francisco.

142. SERPENTINE, center of Lone Mountain Cemetery, San Francisco.

143. SERPENTINE (five varieties), Lone Mountain Cemetery, San Francisco.

144. SERPENTINE, Market Street Cut, San Francisco.

145. SERPENTINE SCHISTOSE, met with before reaching the so called footwall, New Almaden Quicksilver Mine, Santa Clara County.

146. SERPENTINE, Kelseyville, Lake County.

147. SERPENTINE, Bald Prairie, Placer County.

148. SERPENTINE, Monterey, Monterey County.

149. SHALE (with Lignite), near San Bernardino, San Bernardino County.

150. SHELL ROCK, Sandstone Bluff, township one north, and on the Humboldt meridian, Humboldt County.

151. SILICIOUS BRECCIA, Little Butte, section thirteen, township thirteen south, range thirty-five east, Mount Diablo meridian.

152. SLATE AND GRANITE, Bodie District, Mono County.

153. SLATE AND PYRITES, Mariposa Tunnel, two thousand six hundred and twenty foot point, Mariposa County.

154. SLATE, which crops out over a large extent of country between San Andreas and Cave City, Calaveras County; strike nearly west northwest, dip nearly vertical.

155. SLATE, near Red Hill, Butte County.

156. SLATE, near Emigrant Gap, Placer County.

157. SLATE, roofing, El Dorado County.

158. STRATIFIED FORMATION, old lime kiln, near Clipper Gap, Placer County.

159. SYENITE, Point San Pedro, San Mateo County, eighteen miles south of San Francisco.

160. TALCOSE ROCK, wall rock of the Idaho Mine, Grass Valley, Nevada County.

161. TALCOSE SLATE, Tuolumne County.

162. TALCOSE SLATE, El Dorado County.

163. TRACHYTE, near St. Helena, Napa County.

164. TRIPOLITE, Santa Barbara.

165. TUFA, Kern County.

166. TUFA, Sulphur Springs, Mono County.

167. TUFA, very interesting formation, Gold Gravel Hydraulic Mine, La Porte, Plumas County.

168. VOLCANIC BRECCIA, used as a building stone in Susanville. It is said to resist the action of fire, as shown during a recent conflagration in that town. Section five, township twenty-nine north, range thirteen east, eight and one half miles from Susanville, Lassen County.

169. VOLCANIC CONGLOMERATE, Mono Lake, Mono County.

170. VOLCANIC ROCK, Kelsey Valley, Lake County, taken from a well ten feet deep. It is several feet in thickness. Sinking the well was discontinued, owing to the emanation of large quantities of carbonic acid gas.

171. VOLCANIC ASH (allied to pumice stone), Calaveras County, eighteen miles from Lodi.

172. VOLCANIC TUFA (so called white lava). A similar rock is used in Europe in building ovens for bread baking. Found near Etna Springs, Napa County.

173. VOLCANIC ASH, Chalk Bluffs, Nevada County.

174. VOLCANIC ASH, Ione Valley, Amador County.

175. VOLCANIC ASH, Tufa or Lava, Mono County, near Carson and Colorado Railroad.

The following have been added since the publication of the second volume of the museum catalogue:

176. ANTHRACONITE, cave at Murphy's, Calaveras County.

177. BITUMINOUS SHALE, from which oil and gas can be manufactured, Calistoga, Napa County.

178. BRECCIATED QUARTZ, vein matter, Calistoga or Venus Mine, Mt. St. Helena, Napa County.

179. BROWN COAL (Lignite), from vein near Lancha Plana, Calaveras County.

180. BUILDING STONE, Valley Springs, Calaveras County.

181. CAPROCK, used for paving sluices, worn from thickness of eighteen inches by eight months' use, Spring Valley Mine, Cherokee, Butte County.

182. CONCRETION, resembling a geode, Bottle Hill, El Dorado County.

183. DUNNITE, from Carga Muchacho gold mining district, San Diego County. This rock is more minutely described elsewhere.

184. FELDSPAR (orthoclase), Hunsecker Grade, stage road from San Diego to Julian, San Diego County.

185. FREESTONE, from Stony Brook, near Niles, Alameda County, on the property of J. D. Farwell. It seems to possess many of the qualities which characterize a good building stone. In the quarry where the croppings have long been exposed to the elements, it shows evidences of great durability, as it does laid in the piers and abutments of the railroad bridge which crosses the Alameda Creek near by. This block has been sculptured by Morton A. Edwards, of San Francisco, and was presented by J. D. Farwell.

186. LAVA, used in building at Mokelumne Hill, Calaveras County. Three varieties. It is a durable and convenient material, and could be more generally utilized.

187. PEGMATITE, Hunsecker Grade, stage road from San Diego to Julian, San Diego County.

188. ROCK SPECIMEN, from the summit of Mt. St. Helena, altitude 4,343 feet. It rises in columns like basalt, in large outcrops; the whole summit of the mountain is of this formation. The soil produced by its disintegration is of a pale green color. Napa County.

189. ROCK SPECIMEN, from the side of Mt. St. Helena, Napa County.

190. ROCK RESEMBLING HALLEFLINTA, found on the sides of Mt. St. Helena, Napa County.

191. ROCK SPECIMEN, with veins of cinnabar, Manhattan Mine, Napa County.

192. ROCK SPECIMEN, near Deffebach's Ranch, one mile from the bay, Sausalito, Marin County.

193. ROCK SPECIMEN, from first tunnel on N. P. C. R. R., Blithdale Station, Marin County.

194. ROCK SPECIMEN, with microscopical section, Union Mine, near San Andreas, Calaveras County, believed to be slaty serpentine.

195. ROCK CONTAINING FOSSIL TURRITELLA. Section thirty-three, township twenty-two south, range sixteen east, Mt. Diablo meridian. Fossils are very abundant at this locality.
196. SAND, from the beach, near the whaling station, Monterey, Monterey County.
197. SAND, from opposite the bath house, Santa Barbara.
198. SAND, from the ocean beach, two miles south of Pescadero, San Mateo County.
199. SERPENTINE, Point Tiburon, Marin County.
200. SERPENTINE FOLIATED, altered to Picrolite, found in considerable quantity in Mendocino County, township nineteen north, range ten west, Mt. Diablo meridian.
201. SILICIOUS MINERAL, OR ROCK, probably a deposition from hot mineral water. This specimen is opaque, and shows the effect of solfataric action about the orifices, round the mouths of which little ridges of silica have been deposited. Manhattan Quicksilver Mine, Napa County.
202. STEATITE, Coulterville, Mariposa County. Of excellent quality, and said to be in large quantities.
203. WALL ROCK, Manhattan Mine, Napa County.
204. WALL ROCK WITH FOSSILS, Manzanita Gold Mine, Sulphur Creek, Colusa County.

An excellent building stone is found in a white rock, of sedimentary origin, thought to be volcanic ash. It is found in the foothills over a large extent of country. It has been used in building in Mokelumne Hill, Calaveras County, for many years, where it has been found to be very durable. The walls of some buildings which were destroyed by fire are uninjured, or only slightly so. There are some fine buildings being constructed of this stone in St. Helena, in Napa County. Their general appearance is very fine. This material should be introduced into San Francisco and other large towns.

Basaltic rocks are quite common in numerous localities in the State. In Butte County, between Oroville and Magalia, there are large outcrops of cellular lava and fine columnar bluffs. The stone is of excellent quality, and quite suitable for pavements and building. The basaltic columns of Mount St. Helena have been described elsewhere.

EXAMINATION OF DUNNITE FROM SAN DIEGO COUNTY—NO. 183 OF THE ABOVE LIST.

Color pale green, with dark spots. It consists of three distinct minerals—*olivine*, *magnetite*, and a *micaceous mineral*, unknown.

In its natural state it slightly deflects the needle. When pulverized, a portion can be removed by the magnet, and on heating to redness, a second smaller portion becomes magnetic, and can be separated in the same way. A sample of rock was pulverized, sized by sifting, and placed in a long glass tube full of water. On placing the tube in a vertical position, the magnetite fell first. The other two minerals did not separate, but fell together, showing that they had nearly the same specific gravity.

Another portion was divided into three parts by the magnet as follows:

(A) magnetic	12.2
(B) magnetic by heating	2.1
(C) non-magnetic	85.7
	100.0

The non-magnetic portion (C) was examined under the microscope and found to consist of two minerals, one dark colored, but which changed to bronze color by heating. The other was pale green in nearly transparent angular particles, with vitreous luster. Being of the same sized particles, of nearly the same specific gravity, they were counted under the microscope and found to be in equal numbers very nearly, therefore the mechanical analysis would stand thus:

Magnetic (A)	12.20
Magnetic by heating (B)	2.10
Micaceous (D)	42.85
Pale green (E)	42.85
	100.00

The portion (C) from which magnetite had been removed by the magnet was boiled repeatedly in nitro-hydrochloric acid, by which treatment the micaceous mineral was decomposed. The residue being well washed, the pale green mineral (olivine) was left in a state of apparent purity. The specific gravity was found to be 3.321.

This is a beautiful and interesting rock, and one that it would seem might be put to some practical use. Sections cut for the microscope are also very interesting.

The following is the result of an examination of the straw-colored sandstone from Santa Barbara, used in the construction of the old Mission, and latterly in a number of fine modern buildings in the beautiful town of Santa Barbara: Specific gravity, 2.7; one part of the stone by weight absorbed only .012 parts of water. The stone is rather easily reduced to powder; more so when wet. In this respect it resembles the sandstone of a similar color found at San José. Under the microscope the powder is seen to consist of rounded grains of milky quartz. The silica was determined and found to be 75 per cent. The specific gravity being as above, a cubic foot would weigh 168.75 pounds. While this is a beautiful and easily worked building stone, its use in the old Mission has shown that it is not very durable.

TABLE OF ALTITUDES.

The first 1,109 are copied from Bulletin of the United States Geological Survey No. 5; the remainder are gathered from various sources, and may be considered as approximative. They are probably as correct as those generally first published in a new and large State like California.

No.	Station.	Authority.	Elevation. Feet.
1	Abbey Hill	U. S. C. & G. S.	1,232
2	Abbott	U. S. C. & G. S.	375
3	Acampo		59
4	Adalante	Cal. P. R. R.	76
5	Adams, Mt.	Wheeler	8,431
6	Adobe	Wheeler	282
7	Adobe Meadows	Wheeler	6,594
8	Agua Caliente	Emory	3,013
9	Agua Caliente	Wheeler	725
10	Agua Caliente	Wheeler	3,617
11	Alamo Mocho	P. R. R. Reports	—70
12	Alcatraz Island	U. S. C. & G. S.	143
13	Algodones	P. R. R. Reports	46
14	Alpine	C. P. R. R.	2,822

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
15	Alta	C. P. R. R.	3,607
16	Altamont	C. P. R. R.	740
17	Alturas	Wheeler	4,365
18	Alturas Hill	Wheeler	4,459
19	Amys' Ranch	Wheeler	1,494
20	Anaheim	C. P. R. R.	130
21	Anderson	Toner	33
22	Anderson, Mt.	Whitney	9,000
23	Angel Island, N. W.	U. S. C. & G. S.	159
24	Angel Island Peak	U. S. C. & G. S.	782
25	Aneta	Toner	161
26	Antelope	C. P. R. R.	154
27	Antelope Ranch	Wheeler	359
28	Antelope Spring	Wheeler	4,272
29	Arab Spring	Wheeler	5,697
30	Arcade	C. P. R. R.	55
31	Arlington Bridge	Wheeler	3.375
32	Ash Springs	Wheeler	1,810
33	Auburn	C. P. R. R.	1,360
34	Auburn	Smithsonian Institute	1,176
35	Aurora	Wheeler	7,449
36	Advisadera, Point	U. S. C. & G. S.	171
37	Azusa	Wheeler	594
38	Babbitt, Camp	Williamson	384
39	Bache, Mt.	U. S. C. & G. S.	3,793
40	Bache, Mt.	Peterman	3,790
41	Bacons' Ranch	Wheeler	4,076
42	Bagley's Ranch	Wheeler	5,387
43	Bah-li-vah Spring	Wheeler	6,284
44	Bakersfield	Wheeler	432
45	Baker's Ranch	Toner	3,285
46	Bald Mountain	Wheeler	5,829
47	Bald Mountain	Wheeler	8,295
48	Bald Rock	Wheeler	7,825
49	Balley, Mt.	Whitney	6,357
50	Ballona	L. A. & I. R. R.	103
51	Bantas	C. P. R. R.	30
52	Bardins	Monterey R. R.	48
53	Bare Mountain	Wheeler	6,039
54	Bares' Ranch, Surprise Valley	Wheeler	4,680
55	Barker's Ranch	Wheeler	594
56	Barnard's Hotel	Wheeler	3,851
57	Batavia	C. P. R. R.	64
58	Battle Creek Meadows	Wheeler	4,700
59	Battle Hill		2,389
60	Baxter's Station	Wheeler	4,115
61	Bear Valley Post Office	Wheeler	2,087
62	Bear Valley, Town Hotel	Wheeler	6,592
63	Beckworth's Pass	Wheeler	5,193
64	Beckworth's Pass	R. R. surveys	4,682
65	Beckworth's Pass	Whitney	5,327
66	Beckworth's Store	Wheeler	4,887
67	Bell Mill	Wheeler	3,681
68	Bello	Cal. P. R. R.	203
69	Benicia Arsenal	U. S. C. & G. S.	6
70	Benicia Barracks	Med. Dept., U. S. A.	64
71	Bennett's Wells, Death Valley	Wheeler	—68
72	Berenda	Toner	256
73	Bidwell	Wheeler	4,612
74	Bidwell Camp	Wheeler	4,647
75	Bidwell Camp	Med. Dept., U. S. A.	4,680
76	Bidwell, Mt.	Wheeler	8,551
77	Bidwell's Bar, South Fork Feather River	Wheeler	342
78	Bielowski	Whitney	3,269
79	Biggs's	C. P. R. R.	124
80	Big Logan	Toner	70
81	Big Meadow Ranch	Wheeler	6,464
82	Big Meadows	Wheeler	4,234
83	Big Oak Flat	Wheeler	2,823

TABLE OF ALTITUDES—Continued.

No.	STATION.	Authority.	Elevation. Feet.
84	Big Springs	Wheeler	4,553
85	Big Tree Grove, Calaveras County	Wheeler	4,794
86	Big Tree Station	Wheeler	3,925
87	Birds' Springs	Wheeler	3,949
88	Black Bluff	U. S. C. & G. S.	208
89	Black Mountain	U. S. C. & G. S.	2,811
90	Blackmore's Ranch	Wheeler	2,230
91	Black Ridge	U. S. C. & G. S.	756
92	Black Springs	Wheeler	6,485
93	Blodgett's Ranch	Wheeler	216
94	Blood's Station	Wheeler	6,979
95	Blue Cañon	C. P. R. R.	4,693
96	Bluff Point	U. S. C. & G. S.	177
97	Board Ranch	Wheeler	4,639
98	Boca	Wheeler	5,230
99	Boca	C. P. R. R.	5,531
100	Bodega Head	U. S. C. & G. S.	241
101	Bold's Ranch	Wheeler	141
102	Bonita, Point	U. S. C. & G. S.	283
103	Boneyard Ranch	Wheeler	2,450
104	Bootjack Ranch	Wheeler	2,107
105	Borden	Toner	172
106	Boston Peak	Wheeler	6,519
107	Bower Cave	Wheeler	2,360
108	Box Elder		1,430
109	Boyd's Ranch	Wheeler	622
110	Bozeman's Ranch	Wheeler	3,157
111	Brandy City		3,592
112	Breccia Pass	Goddard	10,150
113	Breckinridge, Mt.	Wheeler	5,693
114	Breckenridge, Mt.	Wheeler	7,418
115	Brewer, Mt.	Whitney	13,886
116	Brewery	Wheeler	2,838
117	Bridgeport	Wheeler	1,357
118	Pridgeport Post Office	Wheeler	6,423
119	Brighton	S. & P. R. R.	42
120	Brighton, cross S. V. R. R.	C. P. R. R.	54
121	Broncho	Wheeler	5,310
122	Brown's Flat	Wheeler	1,964
123	Brown's Peak	Wheeler	5,392
124	Brown's Ranch	Wheeler	1,759
125	Buckeye	Wheeler	4,938
126	Buckhorn Ranch (or Warren Station)	Wheeler	693
127	Buck's Ranch	Wheeler	5,112
128	Buena Vista	Wheeler	323
129	Buena Vista	Nev. Co. N. G. R. R.	2,618
130	Buena Vista Oil Works		790
131	Buffalo Station	Wheeler	4,378
132	Burrows, Mt.	Wheeler	4,267
133	Burst Rock	Wheeler	9,157
134	Bush Hill	U. S. C. & G. S.	482
135	Butte Creek Bridge	Wheeler	4,692
136	Butte Creek House	Wheeler	5,758
137	Butt, Mt.	Wheeler	7,830
138	Byrnes' Ferry	Wheeler	380
139	Cady, Camp	Wheeler	1,894
140	Cahto	Smithsonian Inst.	2,000
141	Cahuenga Pass	Wheeler	750
142	Cajon Pass	Pacific R. R. Reports	4,676
143	Cajon Pass Divide	Wheeler	4,195
144	Cajon Ranch	Pacific R. R. Reports	412
145	Calaveras Grove	Wheeler	4,730
146	Caliente	C. P. R. R.	1,290
147	Caliente	Wheeler	1,314
148	Caliente Springs	Wheeler	3,688
149	California City Point	U. S. C. & G. S.	75
150	Calistoga	C. P. R. R.	331
151	Campo, Signal Station	U. S. Signal Office	2,527
152	Camptonville	Toner	2,388

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
153	Camp Weldon (Mountain)	Wheeler	2,716
154	Canebrake Ranch	Wheeler	3,904
155	Cannelas Ranch	Wheeler	799
156	Cannon	C. P. R. R.	90
157	Cañon de Turruco Pass		4,256
158	Cañon Spring	Wheeler	1,238
159	Cañon Station	Wheeler	2,650
160	Capitan Grande	Pacific R. R. Reports	730
161	Caples Ranch	Wheeler	7,780
162	Caples Spring	Wheeler	5,512
163	Carbondale	C. P. R. R.	222
164	Caribou Bridge, North Fork	Wheeler	2,843
165	Carizzo		431
166	Carlos, Mt.	Whitney	4,977
167	Carmel, Mt.	U. S. C. & G. S.	4,415
168	Carnelian Hot Springs	Wheeler	6,237
169	Carson Cañon Toll House	Wheeler	6,596
170	Carson Pass	Goddard	7,972
171	Carson Pass	Whitney	8,759
172	Carson Pass	Wheeler	8,634
173	Cartago		3,589
174	Carthage, on Owens Lake	Wheeler	3,589
175	Cary, Mt.	Wheeler	9,970
176	Cascade	C. P. R. R.	6,538
177	Castle, Mt.	Wheeler	9,013
178	Castle Peak	Whitney	12,500
179	Castle Rock	Wheeler	9,872
180	Castroville, on line of S. P. R. R.	Monterey R. R.	19
181	Catherines	S. P. R. R.	512
182	Cathedral Rock (lower)	Wheeler	6,430
183	Cathedral Rock (higher)	Wheeler	6,529
184	Cathey's Ranch	Wheeler	1,260
185	Cavallos, Point de los	U. S. C. & G. S.	126
186	Coyote Ridge	U. S. C. & G. S.	1,034
187	Cedar, Mt.	Wheeler	8,308
188	Cedar Point	Toner	5,614
189	Cedarville	Wheeler	4,675
190	Centerville	Wheeler	503
191	Cerro Gordo Landing, Col. River	Wheeler	3,656
192	Cerro Gordo Pass	Wheeler	8,874
193	Chapman's Ranch	Wheeler	4,992
194	Chapperal House	Wheeler	5,076
195	Chemehuevis Pass	K. P. R. R. Surveys	675
196	Chico	C. P. R. R.	193
197	Chico	Smithsonian Inst.	150
198	Chico	Wheeler	177
199	Chinese Camp	Wheeler	1,299
200	Chiquita Peak	Wheeler	8,136
201	Chuckawalla	Wheeler	2,095
202	Cicero	C. P. R. R.	90
203	Cienega	L. A. & I. R. R.	121
204	Cisco	C. P. R. R.	5,934
205	Cisco (site) South Fork Yuba River	Wheeler	5,654
206	Clark Peak	Wheeler	11,295
207	Clark's	Wheeler	3,925
208	Clark's Ranch	Wheeler	4,677
209	Clayton	Smithsonian Inst.	76
210	Clear Lake	Wheeler	5,808
211	Clipper Gap	C. P. R. R.	1,759
212	Cloud Rest	Wheeler	9,772
213	Clover Valley	Wheeler	3,464
214	Cohen's Ranch	Wheeler	281
215	Cohuilla Village	Pacific R. R. Reports	85
216	Colby's Ranch	Wheeler	4,990
217	Cold Spring	Wheeler	3,126
218	Cold Spring	Wheeler	5,375
219	Cold Spring Ranch	Wheeler	565
220	Cole's Ranch	Wheeler	1,221
221	Coleville (blacksmith shop)	Wheeler	5,190

TABLE OF ABTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
222	Colfax	Nev. Co. N. G. R. R.	2,422
223	Colfax	Wheeler	3,022
224	Colfax Junction, with Nevada Co. R. R.	C. P. R. R.	2,422
225	Colona		835
226	Colton	Wheeler	808
227	Colton	C. P. R. R.	965
328	Columbia	Toner	2,314
229	Columbia P. O.	Wheeler	2,157
230	Columbia Rock (above valley)	Wheeler	5,005
231	Conejos	Wheeler	2,565
232	Conejas Ranch	Wheeler	579
233	Conness Peak	Wheeler	12,518
234	Contra Costa	U. S. C. & G. S.	96
235	Cook's Point (Mountain)	Wheeler	6,336
236	Cook's Wells	Pacific R. R. Reports	—62
237	Coomb's Station	Wheeler	2,886
238	Cooper's Ranch	Wheeler	8,406
239	Copperopolis P. O.	Wheeler	1,015
240	Corbett's Ranch	Wheeler	1,075
241	Corcoran, Mt.	Wheeler	14,093
242	Cordelia	C. P. R. R.	11
243	Cordelia	Pacific R. R. Reports	69
244	Cory's Peak	Wheeler	11,326
245	Costa	C. P. R. R.	85
246	Cottonwood	Toner	423
247	Cottonwood Island	Wheeler	787
248	Cottonwood Station	Wheeler	2,488
249	Coulterville	Wheeler	1,665
250	Cow Creek Ranch, Sonora Road	Wheeler	5,905
251	Cow Head Lake	Wheeler	6,041
252	Cow Head Lake Spring	Wheeler	5,329
253	Cow Spring	Wheeler	3,876
254	Cox's Ferry	Wheeler	250
255	Crabtrees	Wheeler	934
256	Crane Flat	Wheeler	6,054
257	Crane Valley	Wheeler	3,185
258	Crater Station		1,000
259	Crescent City	Smithsonian Inst.	12
260	Crescent City	Wheeler	3,306
261	Cress's Ranch	Wheeler	5,157
262	Creston	C. P. R. R.	313
263	Crimea House	Wheeler	1,221
264	Crook, Fort	Medical Dept. U. S. A.	3,390
265	Crow's Ranch, Clover Valley	Wheeler	5,464
266	Crystal Lake	R. R. Reports	5,907
267	Culbertson's	Wheeler	980
268	Culbertson's Vineyard	Wheeler	981
269	Cucamonga	C. P. R. R.	952
270	Cucamonga	Wheeler	1,328
271	Cucamonga Peak	Wheeler	8,529
272	Cucamonga Ranch	Wheeler	1,168
273	Cuddy's Ranch	Wheeler	5,278
274	Cunningham's Ranch	Wheeler	387
275	Curtis	C. P. R. R.	39
276	Daggett's Pass	Goddard	6,824
277	Dahlonega	Wheeler	2,162
278	Dalton's Ranch	Wheeler	568
279	Dana, Mt.	Whitney	13,227
280	Darwin Cañon	Wheeler	3,143
281	Davis	C. P. R. R.	54
282	Dawes Ranch	Wheeler	451
283	Deadfall Bridge	Wheeler	3,426
284	Deadwood Peak	Wheeler	4,451
285	Decoto	C. P. R. R.	68
286	Deep Spring	Wheeler	4,957
287	Deer Creek	Wheeler	4,518
288	Delaney's Ranch	Wheeler	4,840
289	Delano	C. P. R. R.	313
290	Desert Springs	Wheeler	1,989

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
291	Dewser's Station	Wheeler	2,922
292	Devil's Peak	Wheeler	6,910
293	Diablo Point	U. S. C. & G. S.	202
294	Diablo, Monte, Hotel	U. S. C. & G. S.	2,327
295	Diablo, Monte	U. S. C. & G. S.	3,849
296	Dixon	C. P. R. R.	65
297	Donner Lake	R. R. Reports	5,964
298	Donner Lake	Wheeler	5,885
299	Donner Pass	C. P. R. R. Surveys	7,901
300	Donner Pass	Whitney	7,056
301	Doon's Sawmill	Wheeler	3,420
302	Dos Palmas	Wheeler	103
303	Downey	C. P. R. R.	114
304	Downieville	Smithsonian Inst.	2,200
305	Downieville Buttes	Whitney	8,400
306	Downieville Buttes	Wheeler	8,541
307	Drew's Ranch	Wheeler	1,090
308	Dribblesby's Ferry	Pacific R. R. Reports	954
309	Drune Barracks	Medical Dept. U. S. A.	32
310	Dudley's	Wheeler	2,959
311	Duxbury	U. S. C. & G. S.	797
312	Dugan's	S. & P. R. R	1,106
313	Dunderberg Peak	Wheeler	12,289
314	Dutch Flat	C. P. R. R.	3,395
315	Dutch Henry's Ranch	Wheeler	1,195
316	Dutch Hill Mining Camp	Wheeler	4,692
317	Dyer Mountain, near Big Meadows	Wheeler	7,369
318	Eagle Lake	Wheeler	5,115
319	Eagle Mountain	Wheeler	9,933
320	Eagleville	Wheeler	4,632
321	Ebbitt's Pass	P. R. R. Reports	8,793
322	Echo Peak	Wheeler	11,231
323	Edgar's Spring	Wheeler	4,061
324	Eisen Vineyard	Wheeler	358
325	El Dorado Mill	Wheeler	863
326	Elephant, Mt.	Wheeler	10,418
327	Eleven Mile Station, Mariposa Road	Wheeler	5,567
328	Eliot's Ranch, on Little Truckee River	Wheeler	6,233
329	Elizabeth Lake	Wheeler	3,317
330	Elk Grove	C. P. R. R.	53
331	Elk Horn	Pacific R. R. Reports	89
332	Elkhorn Ranch	Wheeler	1,049
333	Elk Valley		3,751
334	Ellis	C. P. R. R.	76
335	Ellis Mountain	Wheeler	8,675
336	Elmira	C. P. R. R.	75
337	El Monte	Wheeler	329
338	El Paso Mines	Wheeler	4,113
339	Emigrants' Gap	C. P. R. R.	5,221
340	Emigrants' Gap	Pacific R. R. Reports	5,221
341	Eureka		5,223
342	Eureka Valley	Wheeler	5,957
343	Excelsior Hotel	Wheeler	4,570
344	Fandango Peak	Wheeler	7,849
345	Far West, Camp	Medical Dept. U. S. A.	175
346	Fears' Station	Wheeler	3,393
347	Ferguson's Mill	Wheeler	1,389
348	Fifteen Mile Creek	Wheeler	1,267
349	Fisherman's Peak	Wheeler	14,448
350	Fishpond Station	Toner	1,900
351	Florence	C. P. R. R.	153
352	Florin	Toner	42
353	Folsom	S. & P. R. R.	182
354	Forest Ranch	Wheeler	2,217
355	Forgay's Ranch	Wheeler	3,381
356	Fornis' Ranch	Wheeler	4,225
357	Forsee's Ranch	Wheeler	3,587
358	Fort Point	U. S. C. & G. S.	186
359	"Forty-nine," Cañon Pass	Wheeler	6,306

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
360	Foster's Bar	Toner	1,371
361	Foster's Station	Wheeler	3,265
362	Fowler's Peak	Wheeler	1,760
363	Francis' Spring	Wheeler	4,220
364	Frank's Lagoon	U. S. C. & G. S.	497
365	Fredonyer's Peak	Wheeler	7,905
366	Freels' Mountain	Wheeler	10,848
367	Fremont	C. P. R. R.	58
368	Frenchman's Cove	Wheeler	5,565
369	Fresno	C. P. R. R.	294
370	Fresno	Wheeler	314
371	Fresno Flat	Wheeler	2,192
372	Fryes'	Wheeler	2,181
373	Fulsom & Hall's Ranch	Wheeler	4,282
374	Furnace Creek	Wheeler	405
375	Furnace Springs	Wheeler	337
376	Galt Junction	C. P. R. R.	49
377	Gavilan	U. S. C. & G. S.	2,816
378	Gavilan	Whitney	3,381
379	Georgetown	Toner	2,433
380	Georgetown Pass	Whitney	7,119
381	Georgetown Pass	C. P. R. R. Surveys	7,154
382	Gilroy	Toner	193
383	Glenville	Wheeler	3,094
384	Gold Run	C. P. R. R.	3,220
385	Gold Spring Ranch	Wheeler	2,014
386	Goodrich's Ranch	Wheeler	4,883
387	Goose Lake	Wheeler	4,097
388	Gordon's Ranch	Wheeler	737
389	Gorman's Ranch	Wheeler	3,838
390	Goshen	C. P. R. R.	278
391	Goshen Junction (with S. P. R. R.)	C. P. R. R.	280
392	Guano Island	U. S. C. & G. S.	28
393	Granite Spring	Wheeler	1,435
394	Granite Springs	Wheeler	4,115
395	Granite Station	Wheeler	1,744
396	Granite Wells	Wheeler	2,080
397	Grapevine Peak	Wheeler	8,528
398	Grapevine Ranch	Wheeler	2,247
399	Grapevine Spring	Wheeler	2,432
400	Grass Lake	Wheeler	8,564
401	Grass Valley		2,090
402	Grass Valley	Nev. Co. N. G. R. R.	2,454
403	Gravel Range	Wheeler	2,987
404	Gray's Ranch	Wheeler	307
405	Gray's Ranch	Wheeler	1,100
406	Green Bluff	U. S. C. & G. S.	486
407	Green Mountain	Wheeler	1,351
408	Green Mountain	Wheeler	1,352
409	Green's Ranch	Wheeler	4,479
410	Greenville	Wheeler	3,544
411	Gridley	Toner	97
412	Griffith's Ranch	Wheeler	473
413	Grizzly Giant, Mariposa Grove	Wheeler	5,838
414	Grizzly Hill	Wheeler (Theod)	5,709
415	Grizzly Peak	Wheeler	11,723
416	Grizzly Peak	Wheeler	10,369
417	Groveland	Wheeler	2,828
418	Gyser's	Wheeler	5,864
419	Haighs'	Wheeler	1,807
420	Hale's	Wheeler	2,739
421	Halfway House	Wheeler	3,359
422	Halloran Spring	Wheeler	3,272
423	Hamilton Mountain	Whitney	4,440
424	Hamilton (near)	Pacific R. R. Reports	260
425	Hardin's	Wheeler	3,396
426	Harkness Mountain, near Big Meadows	Wheeler (Theod)	8,875
427	Harris' Ranch, Madeline Plains	Wheeler	5,339
428	Harris' Station, Amander Road	Wheeler	5,439

Table of Altitudes—Continued.

No.	Station.	Authority.	Elevation. Feet.
429	Hart's Ranch	Wheeler	242
430	Haskell's Peak	Wheeler	8,126
431	Hat Mountain	Wheeler	7,676
432	Haughtown Crossing	S. & P. R. R.	85
433	Havilah Town	Wheeler	3,150
434	Hays' Station	Wheeler	5,957
435	Hazel Green	Wheeler	5,550
436	Hazelton Peak	Wheeler	2,960
437	Hazel Valley	Wheeler	3,404
438	Helena, Mount	Whitney	4,343
439	Henness Pass	C. P. R. R. Surveys	7,031
440	Henness Pass	Whitney	6,996
441	Hennessy's Bridge	Wheeler	1,821
442	Henry, Mount	Whitney	2,398
443	Hermit Valley	Wheeler	7,039
444	Hickman's Ranch	Wheeler	1,907
445	High Bluff	U. S. C. & G. S.	533
446	High Hill	U. S. C. & G. S.	490
447	Highland Peak	Wheeler	10,956
448	Hill's Ranch	Pacific R. R. Reports	4,131
449	Hite's Cove	Wheeler	1,601
450	Hodgdon's	Wheeler	4,506
451	Hoffmann Peak	Wheeler	10,872
452	Hogle	C. P. R. R.	76
453	Hollister	Toner	284
454	Homestead	S. & P. R. R.	32
455	Honey Lake	Wheeler	3,949
456	Hooker		543
457	Hope Valley	Williamson	7,072
458	Hornitos Hotel	Wheeler	847
459	Horn Spring	Wheeler	5,477
460	Horseley's Station	Wheeler	3,860
461	Hosselkus' Ranch	Wheeler	3,635
462	Hotchkiss Ranch	Wheeler	2,931
463	Hot Springs	Wheeler	6,080
464	Hot Springs	Wheeler	7,384
465	Hot Springs	Wheeler	7,692
466	Hough's Mountain	Wheeler (Theod)	7,391
467	Hovely's Camp	Wheeler	3,860
468	Hubertville	Toner	980
469	Hughes' Ranch	Wheeler	3,122
470	Humboldt, Fort	Med. Dept., U. S. A.	50
471	Humbug Park	Wheeler	4,847
472	Humpahyamup Pass	P. R. R. Reports	5,351
473	Hunter's Ranch	Wheeler	6,274
474	Hunter's Ranch	Wheeler	6,275
475	Huntington, Mohave River	Wheeler	2,899
476	Hupps' Mill	Wheeler	2,667
477	Hyde's Union Sawmill	Wheeler	5,288
478	Illinois Ranch	Wheeler	1,759
479	Illinoistown	Toner	2,234
480	Independence, Camp	Wheeler	3,957
481	Independence, Camp	Smithsonian Inst.	4,800
482	Indian Gulch	Wheeler	951
483	Indian Valley	Toner	3,280
484	Indian Wells	C. P. R. R.	—20
485	Indian Wells	Wheeler	2,608
486	Ingalls, Mount	Wheeler	8,471
487	Inskip Toll-gate	Wheeler	4,808
488	Ione	C. P. R. R.	287
489	Ivanpah	Wheeler	4,238
490	Jackson	Toner	934
491	Jacksonville	Wheeler	602
492	Jelly's Ranch	Wheeler	360
493	Joe's Peak	Wheeler	9,712
494	John's, Mount	Petermann	8,000
495	Johnson's Pass	Goddard	6,752
496	Johnson's Pass	C. P. R. R. Surveys	7,374
497	Johnson's Pass	Simpson	7,222

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
498	Johnson's Pass	Whitney	7,339
499	Johnson's Ranch	Wheeler	3,460
500	Johnson's Ranch, Bresser Creek	Wheeler	5,643
501	Jones, Fort	Med. Dept., U. S. A.	2,570
502	Jones' Mill, near Dutch Flat		3,416
503	Junction House	Wheeler	3,562
504	Junction House, on Reno and Susanville road, near Beckwith's Pass	Wheeler	4,639
505	Junction with Oregon Branch	C. P. R. R.	163
506	Kaweah Peak	Whitney	14,000
507	Keg Spring, Willow Creek	Wheeler	5,757
508	Kern Lake	Pacific R. R. Reports	398
509	Kernville	Wheeler	2,551
510	Kettle Rock Peak	Wheeler	7,843
511	Keystone House	Wheeler	1,093
512	Keysville		2,558
513	Kincaid's Flat	Wheeler	1,589
514	Kincaid's Ranch	Wheeler	1,771
515	King's Springs, Death Valley	Wheeler	—225
516	Kingston	Petermann	1,118
517	Kirkwood's	Wheeler	7,677
518	Knight's Ferry Bridge	Wheeler	180
519	Knight's Landing	C. P. R. R.	43
520	Kress	Nev. Co. N. G. R. R	2,857
521	La Bayonne	Wheeler	16
522	Lagrange	Wheeler	222
523	Lake City	Wheeler	4,624
524	Lake City Pass	Wheeler	7,035
525	Lakeview	Wheeler	4,851
526	La Laguna Ranch	Wheeler	129
527	Lambert's Soda Spring	Wheeler	8,558
528	La Motte's	Wheeler	6,491
529	Lane's Crossing, Mojave River	Wheeler	2,819
530	Lankershin's Ranch	Wheeler	563
531	Lassen's Butte	Wheeler	10,437
532	Lassen's Butte	Whitney	10,577
533	Lathrop Junction with Visalia Division	C. P. R. R.	26
534	Latrobe	S. P. R. R.	782
535	Lava Bed Station	Wheeler	446
536	Lawrence	Toner	66
537	Leach's Point	Wheeler	3,409
538	Leek Spring	Wheeler	7,242
539	Lewis' Ranch	Wheeler	966
540	Lewis' Ranch, near Loyalton	Wheeler	4,949
541	Lievre Ranch	Wheeler	3,756
542	Lillie's Ranch	Wheeler	3,647
543	Lime Point Bluff	U. S. C. & G. S.	495
544	Lincoln	C. P. R. R.	161
545	Lion's Head	Wheeler	1,693
546	Little Yosemite	Wheeler	6,442
547	Livermore	C. P. R. R.	485
548	Livermore Pass	Whitney	686
549	Liverpool Landing, Colorado River	Wheeler	606
550	Lobos Point	U. S. C. & G. S.	326
551	Lobos Point	U. S. C. & G. S.	378
552	Lodi	C. P. R. R.	55
553	Lomo	Wheeler	3,848
554	Lone Pine	Wheeler	3,810
555	Longville	Wheeler (Theod.)	4,309
556	Lookout Hill	Wheeler	4,214
557	Lookout Mountain	Wheeler	9,670
558	Loomis' Ranch	Wheeler	4,357
559	Lopez Ranch	Wheeler	3,248
560	Los Angeles	C. P. R. R.	265
561	Los Angeles	Wheeler	326
562	Los Angeles	Pacific R. R. Reports	250
563	Los Angeles, San Pedro Dessa	L. A. & I. R. R	260
564	Los Angeles, Signal Station	U. S. Signal Office	350
565	Los Encinos Ranch	Wheeler	772

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
566	Los Pozos Ranch	Wheeler	259
567	Los Toros	Wheeler	203
568	Lott's Diggins	Wheeler	6,310
569	Luther's Pass	Goddard	7,185
570	Luther's Pass	Simpson	7,505
571	Lyell, Mt.	Wheeler	13,190
572	Lyell, Mt.	Whitney	13,217
573	Lyon's Ranch	Wheeler	1,397
574	McBride's	Wheeler	5,561
575	McBride's Peak	Wheeler	13,441
576	McConnahas'	Wheeler	3,981
577	McCumber's Mill	Pacific R. R. Reports	3,491
578	McDonald Peak	Wheeler	7,954
579	McDonald Ranch	Wheeler	5,297
580	McGill, Mt.	Wheeler (Theod.)	9,214
581	McKesick's Peak	Wheeler	7,083
582	McKesick's Ranch	Wheeler	4,469
583	McQuade's	Wheeler	1,888
584	Macon	Toner	450
585	Madeline Hat Peak	Wheeler	7,676
586	Madeline Pass	P. R. R. Reports	5,667
587	Malaga	Wheeler	2,320
588	Mapes	Wheeler	5,039
589	Mare Island, N. E.	U. S. C. & G. S	283
590	Mare Island, N. W.	U. S. C. & G. S.	101
591	Mare Island	U. S. C. & G. S.	29
592	Marin Island	U. S. C. & G. S.	74
593	Marion	U. S. C. & G. S.	74
594	Mariposa	Wheeler	1,962
595	Mariposa Town Hall	Wheeler	1,971
596	Mariposa Post Office	Wheeler	1,942
597	Mariposa Peak	Whitney	3,700
598	Markleeville	Wheeler	5,525
599	Marlett's Lake	Wheeler	7,750
600	Marlett's Peak	Wheeler	8,631
601	Marlett's Ranch	Wheeler	8,074
602	Marl Spring	Pacific R. R. Reports	3,793
603	Martinez, East	U. S. C. & G. S.	187
604	Martinez C. H.	U. S. C. & G. S.	27
605	Martin's	Monterey R. R.	16
606	Martin's	Monterey R. R.	1,982
607	Martin's Ranch	Wheeler	2,055
608	Marysville	C. P. R. R.	67
609	Marysville	Smithsonian Institute	80
610	Master's Hill	U. S. C. & G. S	2,445
611	Matthews' Ranch	Wheeler	6,294
612	Maturango, Mt.	Wheeler (Theod.)	8,844
613	Mayfield	Toner	34
614	Mayhews	S. & P. R. R.	58
615	Meade, Mt.	Wheeler	10,540
616	Meadow Mountain	Wheeler	11,734
617	Meadow Valley	Wheeler	3,757
618	Melrose	C. P. R. R.	18
619	Menatchey Valley	Wheeler	9,503
620	Merced	C. P. R. R.	173
621	Merced Falls	Wheeler	360
622	Merced, Mt.	Wheeler	11,413
623	Merritt's	C. P. R. R.	54
624	Mesquite Spring	Wheeler	2,010
625	Mesquite Wells		3,674
626	Middle Lake, Surprise Valley	Wheeler	4,551
627	Midway	C. P. R. R.	356
628	Mill Creek, Sonora road	Wheeler	7,076
629	Miller, Fort	Med. Dept., U. S. A.	402
630	Miller's Ranch	Wheeler	4,055
631	Mills of Madera Flume and Trading Co.	Wheeler	4,499
632	Milton	Wheeler	376
633	Milton	Wheeler	5,845
634	Mineral Bar	Toner	1,121

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
635	Mitchell's Ranch	Wheeler	4,285
636	Moccasin, Mt.	Wheeler	2,791
637	Modesto	C. P. R. R.	93
638	Mojave	C. P. R. R.	2,751
639	Mokelumne	Toner	5,523
640	Mokelumne, Mt.	Wheeler	9,467
641	Molate Island	U. S. C. & G. S.	169
642	Molate Point	U. S. C. & G. S.	133
643	Mono Lake	U. S. Geol. Survey	6,730
644	Mono Pass	Whitney	10,765
645	Monte	Toner	354
646	Monte Diablo	Whitney	3,856
647	Monterey	Monterey R. R.	7
648	Monterey	Med. Dept., U. S. A.	140
649	Moonlight Valley	Wheeler	5,433
650	Moquelumne Hill	Smithsonian Institute	1,502
651	Moran's Ranch	Wheeler	3,984
652	Mormon Bar	Wheeler	1,630
653	Morocojo	Monterey R. R.	15
654	Morongo Basin	Toner	1,500
655	Morrow, Mt.	Wheeler	2,065
656	Mosquito Spring	Wheeler	2,010
657	Mountain House	Wheeler	5,641
658	Mud Spring, Amador road	Wheeler	5,973
659	Mud Springs	Wheeler	4,671
660	Murphy	U. S. C. & G. S.	2,703
661	Murphy's Cabin, Lake Tenaiya	Wheeler	7,971
662	Murphy's Mining Village	Wheeler	2,195
663	Murphy's Ranch, Buffalo Salt Works	Wheeler	3,845
664	Myers' Ferry	Wheeler	7,434
665	Myers' Station	Wheeler	3,759
666	Nadean's Station	Wheeler	2,394
667	Napa	C. P. R. R.	18
668	Napa Junction	C. P. R. R.	8
669	Napa Junction (Adalante)	C. P. R. R.	76
670	Nash's Ranch	Wheeler	4,431
671	Nelson	Toner	125
672	Nevada City	Nev. Co. N. G. R. R.	2,531
673	Newbury Peak	Wheeler	3,375
674	Newbury Park	Wheeler	830
675	Newcastle	C. P. R. R.	956
676	Newhall	C. P. R. R.	1,152
677	Newhall's Ranch	Wheeler	974
678	New Pass	P. R. R. Reports	3,164
679	New York Tent	Wheeler	1,143
680	Niagara Creek, Sonora road	Wheeler	6,690
681	Nicholas (near)	Pacific R. R. Reports	289
682	Nichols Point	Wheeler	6,262
683	Niles Junction with San José Branch	C. P. R. R.	88
684	Nimshew	Wheeler	2,451
685	Noble's Pass	Wheeler	5,963
686	Noble's Pass	Williamson	6,260
687	Noman's Spring	Wheeler	3,735
688	Nora	C. P. R. R.	153
689	Nordhoff	Wheeler	819
690	North Dome (above valley 3,633)	Wheeler	7,484
691	North End Peak	Wheeler	8,472
692	Northups (Excelsior Hotel)	U. S. C. & G. S.	4,519
693	Norwalk	C. P. R. R.	95
694	Nott's Ranch	Wheeler	7,110
695	Null's Ranch	Wheeler	1,299
696	Oakdale	Wheeler	149
667	Oak Knoll	C. P. R. R.	102
698	Oakland	C. P. R. R.	12
699	Oakland Wharf	C. P. R. R.	14
700	Observation Peak	Wheeler	8,009
701	Ogburn's Ranch	Wheeler (Theod.)	2,270
702	Olancha Peak	Wheeler	12,250
703	Old Bony Mountain	Wheeler	1,892

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
704	Old Kimshew Settlement	Wheeler	4,992
705	Omjumi, Mountain	Whitney	8,378
706	Omjumi, Mountain	Wheeler	8,292
707	Orange	C. P. R. R.	134
708	Oroville	Wheeler	188
709	Oso Meadows	Wheeler	5,982
710	Oso Mountain	Whitney	3,363
711	Owens' River Bridge	Wheeler	3,618
712	Pacheco	U. S. C. & G. S.	21
713	Pacheco Pass	Whitney	1,470
714	Pacheco's Peak	Whitney	2,845
715	Pacific House	Wheeler	3,451
716	Pah Ute Mines	Wheeler	6,607
717	Pah Ute Peak	Wheeler	8,342
718	Pah Ute Springs	Wheeler	2,849
719	Pajaro	Toner	22
720	Paleta Peak	Wheeler	4,507
721	Palmer's Ranch	Wheeler	2,346
722	Pampa	Wheeler	871
723	Panamint	Wheeler	6,605
724	Panamint Station	Wheeler	3,549
725	Panoche Pass	Whitney	2,500
726	Panola	Toner	48
727	Paradise	Toner	125
728	Paris	C. P. R. R.	400
729	Park	L. A. & I. R. R.	178
730	Parker's Ranch	Wheeler	4,136
731	Parrott's (formerly Pandola) Ferry	Wheeler	834
732	Peach Spring	Wheeler	5,303
733	Peddler's Hill	Wheeler	6,831
734	Peña Blanca (Haigh's Ranch)	Wheeler	1,807
735	Peninsula Hill	U. S. C. & G. S.	367
736	Penole, Point	U. S. C. & G. S.	68
737	Penryn	Toner	624
738	Perkins	S. P. R. R.	51
739	Petalume Creek	U. S. C. & G. S.	111
740	Phillips' Ranch	Wheeler	6,999
741	Phillips' Ranch	Wheeler	242
742	Phillips' Station	Wheeler	6,871
743	Pilot Knob	Wheeler	5,525
744	Pilot Peak	Whitney	7,605
745	Pinos Mountain	Petermann	9,500
746	Pinto Rock	Wheeler	3,903
747	Piute Point	K. P. R. R. Surveys	2,579
748	Placerville	Toner	2,109
749	Placerville	Williamson	1,965
750	Placerville Post Office	Wheeler	1,893
751	Plainsburgh	Toner	209
752	Pleasanton	C. P. R. R.	353
753	Pleasant Valley	Wheeler	2,405
754	Point of Rocks	Wheeler	2,542
755	Porcupine Flat	Wheeler	7,749
756	Potraro	Wheeler	1,028
757	Prattville	Wheeler	4,394
758	Priest's Hotel	Wheeler	2,558
759	Princeton	Wheeler	2,104
760	Probasco's Ranch	Wheeler	973
761	Pulgas Base, East End	U. S. C. & G. S.	19
762	Pulgas Base, West End	U. S. C. & G. S.	129
763	Pyramid Mountain	Wheeler	10,127
764	Quincy	Wheeler	3,381
765	Quiqualmingo	Toner	1,084
766	Railroad Flat	Wheeler	2,606
767	Rancho del Chino y de Jurupa	Med. Dept. U. S. A.	1,000
768	Ravenna	C. P. R. R.	2,347
769	Rawhide Camp	Wheeler	1,556
770	Rawson	Wheeler	228
771	Read	U. S. C. & G. S.	474
772	Reading, Fort	Pacific R. R. Reports	596

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
773	Reading	Pacific R. R. Reports	675
774	Reading	Pacific R. R. Reports	674
775	Reading	Med. Dept. U. S. A.	518
776	Red Bluff	Wheeler	307
777	Red Bluff	Williamson	370
778	Red Bluff	C. P. R. R.	308
779	Red Bluff Signal Station	U. S. Sig. Office	324
780	Redding	C. P. R. R.	556
781	Red Hill Station	U. S. C. & G. S.	188
782	Redmans Ranch	Wheeler	1,181
783	Red Rock Station	Wheeler	2,394
784	Red Slate Peak	Whitney	13,400
785	Redwood City	Toner	10
786	Reilly's Station	Wheeler	1,477
787	Reservoir House	Wheeler	1,013
788	Reservoir in Concord Valley	Wheeler	202
789	Reynolds' Ferry	Wheeler	543
790	Rhett Lake	P. R. R. Reports	4,014
791	Richardson	U. S. C. & G. S.	1,116
792	Richmond Point	U. S. C. & G. S.	192
793	Rincon	Toner	2,050
794	Ripley Mountain	Petermann	7,500
795	Ritgers' Ranch	Wheeler	4,345
796	Roberts' Ferry	Wheeler	184
797	Robertson's	Wheeler	819
798	Roble	Toner	179
799	Rocklin	C. P. R. R.	249
800	Rock Spring	Pacific R. R. Reports	4,898
801	Rocky Island	U. S. C. & G. S.	157
802	Rook's Ranch	P. R. R. Reports	4,181
803	Rose Springs	Wheeler	3,545
804	Ross Mountain	U. S. C. & G. S.	2,205
805	Routiers	S. P. R. R.	72
806	Rowland's Ranch	Wheeler	6,222
807	Rutherford	C. P. R. R.	168
808	Sackett's Wells	Toner	312
809	Sacramento	C. P. R. R.	30
810	Sacramento	Smithsonian Inst.	82
811	Sacramento	Williamson	81
812	Sacramento Signal Station	U. S. Signal Office	70
813	Saddle (Malaga) Mountain	Wheeler	2,896
814	Saint Clair Ranch	Wheeler	1,961
815	Saint Helena	C. P. R. R.	244
816	Salinas City		42
817	Salsbury	S. P. R. R.	126
818	Salt Wells	Wheeler	117
819	San Andreas	Wheeler	1,033
820	San Antonio Peak	U. S. C. & G. S.	9,931
821	San Antonio Peak	Wheeler	10,191
822	San Benito	Smithsonian Inst.	140
823	San Benito Pass	K. P. R. R. Surveys	2,700
824	San Bernardino	Wheeler	950
825	San Bernardino Mountain	Whitney	11,600
826	San Bernardo	Pacific R. R. Reports	1,118
827	San Bruno	Toner	16
828	San Ruenaventura	Toner	12
829	San Carlos Peak	Whitney	4,977
830	Sand Creek	C. P. R. R.	2,315
831	Sand Knoll	U. S. C. & G. S.	227
832	San Diego	Emory	30
833	San Diego Mission	Pacific R. R. Reports	64
834	San Diego Signal Station	U. S. Signal Office	67
835	San Emigdio Store	Wheeler	788
836	San Fernando	C. P. R. R.	1,066
837	San Fernando	Wheeler	1,034
838	San Fernando Pass	Pacific R. R. Reports	1,940
839	San Fernando Peak	Wheeler	3,793
840	San Fernando Tunnel, south mouth	Wheeler	1,429
841	San Felipe	Pacific R. R. Reports	2,176

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
842	San Felipe	Pacific R. R. Reports	2,456
843	San Francisco, Signal Station	U. S. Signal Office	60
844	San Francisco, Presidio	Med. Dept. U. S. A.	150
845	San Francisco	U. S. C. & G. S.	384
846	San Francisquito Cañon	Wheeler	2,382
847	San Francisquito Pass	P. R. R. Reports	3,718
848	San Gabriel	Wheeler	419
849	San Gabriel Church	Wheeler	481
850	San Gabriel Mine	Wheeler	1,703
851	San Gabriel Peak		6,232
852	San Gabriel Range	Whitney 4,500 to	6,500
853	San Gorgonio	C. P. R. R.	2,560
854	San Gorgonio Pass	P. R. R. Reports	2,800
855	San Gorgonio Pass	T. & P. R. R.	2,621
856	San Isabel Rancho	Toner	2,957
857	San Jacinto Mountain	Wheeler	10,987
858	San José	C. P. R. R.	91
859	San José	U. S. C. & G. S.	118
860	San Leandro	C. P. R. R.	48
861	San Lorenzo	Toner	35
862	San Luis Obispo	Toner	402
863	San Luis Pass	P. R. R. Reports	1,556
864	San Luis Rey	Med. Dept. U. S. A.	20
865	San Mateo	Toner	23
866	San Miguel	Toner	616
867	San Pablo Point	U. S. C. & G. S.	97
868	San Pascual	Emory	716
869	San Pedro	Pacific R. R. Reports	30
870	San Pedro Point	U. S. C. & G. S.	356
871	San Pedro Hill	Wheeler	1,462
872	San Quentin, Point	U. S. C. & G. S.	173
873	Santa Ana	U. S. C. & G. S.	3,620
874	Santa Ana	C. P. R. R.	137
875	Santa Ann Hotel	Wheeler	141
876	Santa Barbara	Smithsonian Institute	20
877	Santa Buenaventura	Wheeler	146
878	Santa Catalene	Toner	3,000
879	Santa Clara	Smithsonian Institute	98
880	Santa Cruz Station	U. S. C. & G. S.	359
881	Santa Cruz Point	U. S. C. & G. S.	32
882	Santa Isabella		3,050
883	Santa Isabella Rancho	Pacific R. R. Reports	2,957
884	Santa Monica	L. A. & I. R. R.	20
885	Santa Monica	Wheeler	15
886	Santa Paula	Wheeler	384
887	Santa Rosa Valley	Wheeler	175
888	San Vicente	L. A. & I. R. R.	167
889	Say-qui-to Spring	Wheeler	5,553
890	Schaffers, Mount	Wheeler	6,864
891	School House	S. P. R. R.	109
892	Schultz, Mount	Wheeler	2,275
893	Scodie's Ranch	Wheeler	2,716
894	Semi Pass	P. R. R. Reports	1,577
895	Sentinel Dome (above valley 4,160)	Wheeler	8,011
896	Sesma	Toner	229
897	Sevastapol Flat	Wheeler	2,210
898	Seven Palms	C. P. R. R.	1,126
899	Shafer's Station	Wheeler	4,026
900	Shasta		1,160
901	Shasta, Mount	Whitney	14,442
902	Shasta, Mount (timber line on)		8,000
903	Shaw's Flat	Toner	2,270
904	Shaw's Flat	Wheeler	2,036
905	Shaw's Ranch	Wheeler	6,311
906	Shear's Bridge	Wheeler	2,007
907	Sheep Head	Wheeler	3,914
908	Sheffer's Hot Springs	Wheeler	4,094
909	Sheridan		113

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
910	Shingle Springs	S. P. R. R.	1,427
911	Shinn's Ranch	Wheeler	5,040
912	Shoo-fly Bridge	Wheeler	3,071
913	Shumway's Ranch	Wheeler	5,067
914	Sierra Valley	Wheeler	4,910
915	Sierravile, Junc. of S. T. and L. Road	Wheeler	4,904
916	Sierraville, Post Office	Wheeler	4,880
917	Silliman, Mt.	Whitney	11,623
918	Silver Creek	Toner	3,700
919	Silver Lake Hotel	Wheeler	7,174
920	Silver Mt.	Whitney	10,934
921	Silver Mountain City	Wheeler	6,446
922	Silver Mountain Pass	Whitney	8,793
923	Simi Ranch	Wheeler	674
924	Smith's Ranch	Wheeler	1,047
925	Smoke Creek Depot	Wheeler	4,163
926	Snelling Post Office	Wheeler	252
927	Snider's Store	Wheeler	4,925
928	Snow's Hotel	Wheeler	5,217
929	Soap Spring	Wheeler	706
930	Soda Lake	Pacific R. R. Reports	1,002
931	Soda Lake	Wheeler	1,128
932	Soledad City	Wheeler	2,513
933	Soledad Pass	A. & P. R. R. Surveys	3,215
934	Solfatara	Wheeler	5,908
935	Sonoma Mountain	U. S. C. & G. S.	2,292
936	Sonora Mountain	Wheeler	11,478
937	Sonora Pass	P. R. R. Reports	10,115
938	Sonora Post Office	Wheeler	1,816
939	Soto	Toner	186
940	South Dome (lip) (above valley 4,953)	Wheeler	8,804
941	South Fork Mountain	Wheeler	7,408
942	Spadra	C. P. R. R.	705
943	Spadra	Wheeler	802
944	Spanish Ranch	Wheeler	3,636
945	Sprague's Ranch	Wheeler	2,950
946	Springville	Wheeler	48
947	Stanford Mountain	Whitney	9,175
948	Starr King Mt. (above valley 5,171)	Wheeler	9,022
949	State Line Peak	Wheeler	8,405
950	Stevens Bar Ferry	Wheeler	614
951	Stevens Mountain	Wheeler	10,011
952	Stevens Ranch, Hope Valley	Wheeler	7,382
953	Stockton, Junc. with S. & V. & S. & C. R.R.'s.	C. P. R. R.	23
954	Stockton's Cabin	Wheeler	5,877
955	Stockton Mill	Wheeler	4,639
956	Stokes Mountain	Wheeler	2,069
957	Stonebreakers	Wheeler	4,360
958	Stony Point		500
959	Storms	Nevada County N. G. R. R.	2,424
960	Strawberry	Wheeler	5,238
961	Strawberry Station (toll house)	Wheeler	5,695
962	Strawberry Valley	Toner	3,567
963	Strawberry Valley	Williamson	5,707
964	Sugar Loaf Mountain	Wheeler	8,416
965	Sulphur Peak	U. S. C. & G. S.	3,471
966	Sulphur Spring Ranch	Wheeler	4,466
967	Summit Peak	Wheeler	8,301
968	Summit Post Office, west of Beckwith's Pass	Wheeler	4,875
969	Summit Station	Wheeler	6,983
970	Summit Valley	Toner	6,765
971	Sumner	C. P. R. R.	415
972	Sunday Peak	Wheeler	8,335
973	Sunday Peak	Wheeler	11,089
974	Sunoe	Toner	264
975	Surveyors' Wells	Wheeler	3,567
976	Susanville	Wheeler	4,195

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
977	Suspension Bridge, Mokelumne River	Wheeler	2,092
978	Sutler	Toner	919
979	Swann's Ranch, E. Walker River	Wheeler	5,042
980	Sweetwater Mountain	Wheeler	11,778
981	Sycamore		302
982	Sycamore Grove	Wheeler	447
983	Tahoe City	Wheeler	6,252
984	Tahoe Lake	R. R. Reports	6,247
985	Tamalpais, Mount	Whitney	2,597
986	Tamarac		6,209
987	Tamarack Flat	Wheeler	6,234
988	Tannery	Wheeler	4,400
989	Tapo Ranch	Wheeler	1,373
990	Tassett		83
991	Taylor's Ranch	Wheeler	1,047
992	Taylorville	Wheeler	3,479
993	Tehachapai, Mount	Wheeler (Theod.)	9,214
994	Tehachapai Pass	Wheeler	3,832
995	Tehama	C. P. R. R.	222
996	Tejon, Fort	Med. Dept. U. S. A.	3,240
997	Tejon, Fort	Wheeler	3,245
998	Tejon Pass	P. R. R. Reports	5,364
999	Tejon Ranch	Wheeler	1,450
1000	Telegraph Hill	U. S. C. & G. S.	300
1001	Telescope Mountain	Wheeler (Theod.)	10,937
1002	Temescal Mountain	Wheeler (Theod.)	5,730
1003	Thomas Ranch	Wheeler	3,772
1004	Thompson	C. P. R. R.	9
1005	Thompson's	Wheeler	2,114
1006	Thompson's Ferry	Wheeler	188
1007	Thompson's Peak	Wheeler	7,752
1008	Thunder Mountain	Wheeler	9,121
1009	Tilley's Ranch	Wheeler	2,609
1010	Tipton	C. P. R. R.	267
1011	Todos Santos Pass	P. R. R. Reports	637
1012	Toolucha Peak	Wheeler	7,022
1013	Tomales Bay	U. S. C. & G. S.	673
1014	Topsail Rock	U. S. C. & G. S.	81
1015	Towler's, Napa Valley		369
1016	Town Talk	Nev. Co. N. G. R. R.	2,774
1017	Tragedy Spring	Wheeler	7,989
1018	Trinchera	Wheeler	7,567
1019	Trinidad		5,820
1020	Trout Meadows	Wheeler	5,998
1021	Truckee	C. P. R. R.	5,819
1022	Truckee	Wheeler	5,795
1023	Truckee Pass	P. R. R. Reports	7,200
1024	Truebody	C. P. R. R.	88
1025	Tulare	C. P. R. R.	282
1026	Tulare Lake	Pacific R. R. Reports	398
1027	Tull Flat	Wheeler	5,594
1028	Tullock	Toner	106
1029	Tuolumne Grove	Wheeler	5,794
1030	Turner's Ranch, Sierra Valley	Wheeler	4,904
1031	Tuttletown	Wheeler	1,321
1032	Twin Lake	Wheeler	5,106
1033	Twin Peak	Wheeler	8,824
1034	Twin Peaks	Whitney	8,925
1035	Twist's Ranch	Wheeler	1,121
1036	Tyler's Ranch	Wheeler	4,802
1037	Uhl's Ranch	Wheeler	2,662
1038	Union Camp	Smithsonian Institute	54
1039	Union Hill	Nev. Co. N. G. R. R.	2,706
1040	Vacaville	Toner	175
1041	Vala Citron	Emory	1,539
1042	Vallecito	Toner	1,643
1043	Vallecito Post Office	Wheeler	1,748

TABLE OF ALTITUDES—Continued.

No.	Station.	Authority.	Elevation. Feet.
1044	Vallejo	U. S. C. & G. S.	87
1045	Vallejo	U. S. C. & G. S.	371
1046	Vallejo (North)	C. P. R. R.	26
1047	Vallejo (South)	C. P. R. R.	13
1048	Vergennes Ranch	Wheeler	940
1049	Vina		211
1050	Visalia	Williamson	384
1051	Visalia, Signal Station	U. S. Signal Office	348
1052	Volcano	Wheeler	2,075
1053	Wabler Lake House	Wheeler	6,808
1054	Wades' Meadows	Wheeler	4,567
1055	Wades' Peak	Wheeler	7,153
1056	Wahguyhe Mountain	Wheeler (Theod.)	8,527
1057	Walker's Pass	P. R. R. Reports	5,302
1058	Walker's Pass	Wheeler	5,322
1059	Wallace's Ranch, Warner Lake	Wheeler	4,487
1060	Walnut Grove	C. P. R. R.	308
1061	Warm Springs	C. P. R. R.	46
1062	Warm Springs, Sonora Road	Wheeler	7,385
1063	Warner's Pass	P. R. R. Reports	3,870
1064	Warner's Ranch	P. R. R. Reports	3,021
1065	Warren's Peak	Wheeler	9,668
1066	Washington, Mount	Wheeler	10,802
1067	Washington Quartz Mill	Wheeler	1,032
1068	Watsonville		45
1069	Wancoba Peak	Wheeler	11,267
1070	Webster	C. P. R. R.	24
1071	Welden	Wheeler	2,668
1072	Welds	Wheeler	2,217
1073	Wellington Mountain	Wheeler	7,665
1074	West Point	Wheeler	2,749
1075	West's Ranch	Wheeler	596
1076	Wheatland	C. P. R. R.	84
1077	White Granite Mountain	Wheeler	7,045
1078	White Rock	S. P. R. R.	495
1079	Whitney	Wheeler	10,051
1080	Whitney Meadows	Wheeler	9,371
1081	Whitney, Mt.	Whitney	14,898
1082	Wellington Mountain	Wheeler	7,665
1083	Wild Rose Spring	Wheeler	4,683
1084	Wiley's Station, Amador Road	Wheeler	5,027
1085	Williamson River	Wheeler	4,387
1086	Williamson's Lake		2,588
1087	Willow Lake	Wheeler	5,382
1088	Willow Ranch	Wheeler	4,275
1089	Willow Spring	Wheeler	420
1090	Willow Spring (head of Willow Creek)	Wheeler	5,084
1091	Willow Tree Spring	Wheeler	2,500
1092	Wilson's Ranch	Wheeler	1,115
1093	Woodford's	Wheeler	5,676
1094	Woodland, Junction with N. R. R.	C. P. R. R.	63
1095	Woodland	U. S. C. & G. S.	58
1096	Woods Peak	Whitney	10,552
1097	Workman's Hill	Wheeler	1,363
1098	Workman's Ranch	Wheeler	362
1099	Wright Lake	P. R. R. Reports	4,470
1100	Yellowbally	Petermann	8,000
1101	Yankee Jim's		3,185
1102	Yerba Buena	U. S. C. & G. S.	345
1103	Yosemite Valley	Whitney	4,060
1104	Yosemite Valley (cliffs and domes about it range from 7,000 to 9,000 ft. above sea)	Williamson	3,935
1105	You Bet	Nev. Co. N. G. R. R.	2,172
1106	Yountville	C. P. R. R.	97
1107	Yountville	Cal. P. R. R.	105
1108	Yreka	Williamson	2,731
1109	Yreka Gap	Whitney	6,642

TABLE OF ALTITUDES—Continued.

No.	Station.	Elevation. Feet.
1110	Alleghany, Sierra County	4,375
1111	Altaville, Calaveras County	1,577
1112	American Mine, Nevada County	1,843
1113	Amador City, Amador County	862
1114	Angels, Calaveras County	1,394
1115	Aqueduct City, Amador County	2,435
1116	Argus Peak, Inyo County	6,333
1117	Atkinson's Grade, San Diego County, foot	416
1118	Atkinson's Grade, San Diego County, first bench	726
1119	Atkinson's Grade, San Diego County, summit	1,220
1120	Bald Mountain, Calaveras County, summit	1,801
1121	Bald Mountain, Sierra County, mouth of tunnel	4,489
1122	Ballena Valley, San Diego County	2,440
1123	Banner, San Diego County	2,800
1124	Birchville, Nevada County	1,683
1125	Blacksmith's Flat, El Dorado County	3,831
1126	Blue Tent, Nevada County	3,108
1127	Bonaparte's Hat, Placer County, summit	8,661
1128	Borax Flat, Inyo County	1,800
1129	Borax Works, Inyo County	1,816
1130	Boston Ranch	1,500
1131	Bottle Hill, El Dorado County, crest	2,570
1132	Bowman Dam, Nevada County	5,393
1133	Brady's, Yuba County	211
1134	Bridgeport, Nevada County	1,500
1135	Brownsville, Yuba County	2,125
1136	Buck's Bar, El Dorado County	1,628
1137	Bunker Hill, Sacramento County	267
1138	Burn's Ranch, El Dorado County	2,518
1139	Cajon Ridge, San Diego County	510
1140	Cajon Valley, San Diego County	220
1141	Cajon Valley, San Diego County, eastern rim	375
1142	Canada Hill, Placer County, summit	7,091
1143	Canada Hill, Placer County, Yank's Cabin	6,217
1144	Cave of the Catacombs, Calaveras County	1,708
1145	Centerville, Pilot Hill Post Office, El Dorado County	1,191
1146	Cherokee Flat, Butte County	1,187
1147	Cherokee, Nevada County	2,575
1148	Chili Bar, El Dorado County	931
1149	Christmas Hill, Nevada County, top of	3,225
1150	Cold Spring, Mountain Summit, Placer Couty	3,679
1151	Coleman's Grade, San Diego County, top, five miles from Julian	3,400
1152	Columbia Hill, Nevada County	2,958
1153	Coso, Inyo County	5,884
1154	Coso Mines, Inyo County	6,000
1155	Coso Peak, Inyo County	8,425
1156	Damascus, Placer County	4,006
1157	Dardanelles, Placer County, bed rock	2,677
1158	Dark Cañon, El Dorado County	4,229
1159	Deadwood, Placer County	3,951
1160	Dirty Flat, El Dorado County	2,355
1161	Dogtown (Magalia), upper, Butte County	2,150
1162	Dogtown (Magalia), lower, Butte County	2,080
1163	Doon's House, Butte County	2,940
1164	Douglas Flat, Calaveras County	1,986
1165	Downieville Trail, Summit of, between Rock Creek and Forest City, Sierra County	5,404
1166	Drytown, Amador County	642
1167	Eagle Borax Works, Inyo County	—69
1168	Empire Flat, Nevada County	1,716
1169	Empire Ranch, Yuba County	840
1170	Fairplay, El Dorado County	2,385
1171	Fiddler's Green, Placer County	4,123
1172	Fiddletown, Amador County	1,693
1173	Forbestown, Butte County	2,625

TABLE OF ALTITUDES—Continued.

No.	Station.	Elevation. Feet.
1174	Forest City, Sierra County	4,465
1175	Forest Hill, Placer County	3,237
1176	Forney's, El Dorado County	4,173
1177	Foster's, San Diego County	260
1178	French Corral, Nevada County	1,566
1179	Funeral Mountains, highest peaks, Inyo County	6,754
1180	Georgia Slide, El Dorado County	2,330
1181	Geyser's Springs, Sonoma County	1,900
1182	Gibsonville, Sierra County	5,500
1183	Granite Chief, summit, Placer County	9,144
1184	Greenwood, El Dorado County	1,610
1185	Gregory Mountain, El Dorado County	3,525
1186	Grizzly Flat, El Dorado County	3,949
1187	Grizzly Flat, Placer County	2,982
1188	Gurley's, Yuba County	172
1189	Halfway House, San Diego County (road from San Diego to Julian)	180
1190	Highland Springs, Lake County	1,700
1191	Horse Camp Springs, Inyo County	4,690
1192	Howard Springs, Lake County	2,225
1193	Hunsaker's Grade, San Diego County (four miles from Nuevo)	1,760
1194	Hunsaker's Grade, San Diego County, summit	2,230
1195	Hyatt's, Nevada County	1,259
1196	Indian Diggings, Amador County	3,162
1197	Iowa Hill, Placer County	2,873
1198	Jackson, Amador County	1,243
1199	Jackson Valley, Buttes, summit of	829
1200	Jamison City, Plumas County	4,800
1201	Johnstown, or Garden Valley, El Dorado County	1,951
1202	Jones Hill, El Dorado County, summit of	2,343
1203	Julian City, San Diego County	4,000
1204	Keeler, Inyo County	3,656
1205	King's Hill, Placer County	2,538
1206	Lane's Springs, Calaveras County	1,000
1207	La Porte, Plumas County	4,993
1208	Last Chance, Placer County	4,583
1209	Little Grass Valley, Plumas County	5,025
1210	Little Spanish Hill, crest of, El Dorado County	2,321
1211	Little York, Nevada County	2,839
1212	Logtown, El Dorado County	1,939
1213	Lolo Montez Diggings, Nevada County	2,489
1214	Lone Star Hill, Inyo County	4,911
1215	Lookout Hill, Inyo County	4,214
1216	Malakoff, Nevada County	3,173
1217	Manzanita Hill, summit, Nevada County	3,054
1218	Marble Valley, El Dorado County	925
1219	Michigan Bar, Sacramento County	227
1220	Michigan Bluffs, Placer County	3,491
1221	Mohawk Valley, Knott's Ranch, Plumas County	4,325
1222	Monte Christo	5,056
1223	Montezuma Hill, Nevada County	2,853
1224	Mooney Flat Hill Summit, Yuba County	1,170
1225	Moore's Flat, Nevada County	4,231
1226	Morris Ravine, Butte County	524
1227	Mud Springs, El Dorado County	1,658
1228	Needle Peak, Inyo Connty	7,086
1229	Newtown, El Dorado County	2,482
1230	Nichols' House, Cave City, Calaveras County	1,593
1231	Nine-Mile Station, Inyo County	2,510
1232	North Bloomfield, Nevada County	3,278
1233	Nuevo, San Diego County	1,200
1234	Oliver Mountain Summit, El Dorado County	3,221
1235	Omega, Nevada County	4,201

TABLE OF ALTITUDES—Continued.

No.	Station.	Elevation. Feet.
1236	Onion Valley, Plumas County	6,160
1237	Ophir Mountain, Inyo County	6,063
1238	Oro Flat, Placer County	2,842
1239	Oroville, Butte County	375
1240	Pilot Hill (Summit), El Dorado County	1,857
1241	Pinto Peak, Inyo County	7,267
1242	Plugugly Hill (Summit), Placer County	3,251
1243	Pluto Summit, Placer County	8,633
1244	Post Office Spring, Inyo County	1,294
1245	Prospect Flat, El Dorado County	2,214
1246	Puckerville, Amador County	1,037
1247	Quaker Hill, Nevada County	3,265
1248	Reeds, Yuba County	433
1249	Rice's Bar, Placer County	1,184
1250	Rough and Ready, Nevada County	1,901
1251	Sailor Cañon, Placer County	5,251
1252	Sailor Flat, Nevada County	3,050
1253	St. Helena Mountain, Napa County	4,343
1254	St. Helena Mountain, Napa County, first bench above Toll House	3,825
1255	Salt Spring, Death Valley, Inyo County	—63.9
1256	San Bernardino Hot Springs	1,600
1257	San Juan, Nevada County	2,143
1258	Santa Barbara Hot Sulphur Springs	1,500
1259	Santa Ysabelle Valley, San Diego County	2,700
1260	Sebastopol, Nevada County	1,893
1261	Secret Hill, Summit, Placer County	6,536
1262	Secret House, Placer County	5,423
1263	Sentinel Peak, Inyo County	9,850
1264	Sheep Ranch, Calaveras County	2,273
1265	Sierra City, Sierra County	4,188
1266	Smartsville, Yuba County	758
1267	Smartsville Hill, summit, Yuba County	1,074
1268	Snowy Mountain, Placer County, summit	8,425
1269	Soda Springs, Shasta County	2,363
1270	South Yuba Bridge	420
1271	Spanish Dry Diggings, El Dorado County	2,158
1272	Squaw Valley, Placer County	6,304
1273	Steep Hollow, Nevada County	3,342
1274	Sucker Flat, Placer County	670
1275	Summit, Soda Springs, Placer County	6,009
1276	Sugar Loaf, Butte County, summit	1,647
1277	Sugar Pine Pass, Placer County	7,130
1278	Surprise Cañon, Inyo County	2,650
1279	Sutter Creek, Amador County	1,197
1280	Table Hills east of Owen's Lake, Inyo County	7,343
1281	Table Mountain, Tuolumne County, summit	2,214
1282	Three Prong, Placer County, summit	9,000
1283	Timbuctoo, Yuba County	441
1284	Timbuctoo Mountain, Yuba County	917
1285	Todds Valley, Placer County	2,750
1286	Toll House, St. Helena Mountain, Napa County	2,300
1287	Tucker's Ranch, Plumas County	4,100
1288	Tuscan Springs, Tehama County	600
1289	Volcanoville, El Dorado County	3,081
1290	Water Station, Inyo County	2,110
1291	Webber Hill, El Dorado County, summit	2,184
1292	Whitesel's Ranch, Nevada County	1,686
1293	Wilcox Meadows, El Dorado County	5,344
1294	Wilcox Ravine, Nevada County	2,799
1295	Windy Gap, Inyo County	2,053
1296	Wisconsin Hill, Placer County	2,936
1297	Wilks' Ranch, El Dorado County	3,386

WATER POWER.

In a State like California, in which a large portion of the area is much above sea level, and where there are a multitude of streams, large and small, flowing from the high lands, there must be and are many localities where water power is abundant and available. This very important matter is just beginning to attract attention in California. At Grass Valley, in Nevada County, where gold mining has been the principal business and the support of the people, up to a recent date, steam was almost universally used to drive the quartz mills. But in 1882 the Idaho Company, although possessing the best quartz mine in the State, began to consider the advantage that would be derived from the substitution of water for steam power. They began to buy water from the South Yuba Canal Company, and after an experimental working for a year, found the annual saving over steam to be from $25,000 to $30,000. There are many localities in the mountains and foothills of California where may be found gold quartz veins, water power, and fertile hillside and mountain valley lands. This Piedmont region will support a large population, and is really the most beautiful part of the State. Mines that would hardly pay if steam power was employed, with cheap or free water power, all the operations of mining and milling may be performed, with but few hands. The same water that serves the mill will hoist the ore, pump, force air into the mine for ventilation and power drilling. Almost any quartz vein in California could be made to pay under these circumstances, and the application of this cheap power would add much to the prosperity of the State.

It will soon again be cheaper to move manufactured articles from water power to a market than to make them by steam elsewhere. Water is equally useful for irrigation and mining purposes after being used for water power, as long as it is not allowed to fall below a certain altitude.

IRRIGATION.

Soon after the first excitement caused by the discovery of gold in California began to subside, attention was turned in a limited way to the agricultural resources of the State. It was first supposed—from the peculiar dryness of the summer months, during which rain seldom falls—that the country would never be an agricultural one in any general sense, but this theory was disproved by experience. At the same time it became evident that a different system of culture, suited to the climatic periods of excessive moisture alternating with equally excessive dryness, must be pursued. Experiment led to the adoption of a system of irrigation.

When the new method began to be understood, and intelligently carried out, it was found that most extraordinary crops were the result.

The dry valley lands of Fresno, San Bernardino, Kern, and other southern counties where water has been introduced, are found to be unusually fertile, and beautiful and prosperous settlements have sprung up in what was at first thought to be a desert. The subject of irrigation and the use of the waters of the State for other purposes than navigation, has grown in importance until it is admitted to be the most momentous question now before the people. The rights of riparian owners have been questioned and much useless legislation has been enacted without arriving at any satisfactory conclusion. The debris or mining question goes hand in hand with irrigation, and though seemingly different, is in fact only another phase of the same important subject. Judging from the trouble the ancients had with this same question, it will not be settled in California for some time to

come. The proper and just distribution of the surplus waters of the State, and the extraction of the vast deposits of gold known to exist in the foothills, are matters which have an important bearing on our material interests. To solve this problem, and protect the conflicting interests of those concerned, is work for future legislators, and the more the matter is agitated now, the sooner will a settlement be effected.

In some localities where it is difficult to obtain water from living streams, artesian wells are being sunk, and very successfully. From these wells, in some parts of the State, natural gas escapes in considerable quantities, giving hope that gas-wells similar to those now attracting so much attention in Pennsylvania may yet be discovered. A notable example of this at the present time is at the city of Los Angeles, where a vein of gas was struck in sinking a well. The gas became ignited from a cigarette, and blazed up to a height of ten feet. An article in the Los Angeles *Herald* assumes that a dozen wells sunk within the city limits would each of them yield gas which might be utilized.

The city of Stockton is supplied with water from artesian wells, some, if not all, of which also produce gas as well as water. The wells sunk for oil in various parts of the State, in perhaps a majority of cases, produce gas. This is a subject worthy the attention of scientific and practical men. May not these emanations of gas indicate vast bodies of coal, which we may at any day discover by sinking wells in search of water?

The State Mining Bureau should employ special persons to study and investigate these matters, and preserve in the State Museum sections of the various wells, which would enlarge our information as to the geology of the valleys, and throw light upon their origin.

Mr. George A. Raymond, more thoughtful than most persons engaged in the business of sinking artesian wells, has carefully preserved specimens of borings, and kept a register of the findings. This should be done officially by the State Mineralogist, and all the results published as frequently as possible, in the general interest. Mr. Raymond has donated to the State Museum samples of borings which are specially interesting. The following are copies of these tabulated records, exactly as kept by him on printed blanks.

RECORD OF STRATA IN ARTESIAN WELL

Drilled by Geo. A. Raymond for J. B. Haggin, Kern County, on Sec. 30, T. 29 S., R. 25 E., Mount Diablo Base and Meridian. Screw Casing 5 5-8 inches diameter.

Depth—Feet.	Thickness—Feet.	Character.	Remarks.
12	12	Black clayey soil	
14	2	Sand	Surface water.
24	10	Yellow clay	
27	3	Sand	
49	22	Yellow clay	
57	8	Sand	
68	11	Brown clay	
80	12	Sand	
82	2	Hard pan	
130	48	Sand	
152	22	Clay and cement	
155	3	Hard pan	
185	30	Sand	
191	6	Cement	
193	2	Yellow clay	
220	27	Sand	
225	5	Yellow clay	
245	20	Sand, cement, and hard pan	In streaks very hard.
255	10	Yellow clay	
272	17	Sand and cement	
285	13	White clay	Like potters' clay.
287	2	Sand	
297	10	White clay	Like potters' clay.
330	33	Sand	
342	12	Hard pan	Very hard.
387	45	Sand	
395	8	Hard pan	Very hard.
403	8	Sand	
433	30	Hard pan and clay	Very hard streaks.
455	22	Hard pan and cement	Very hard streaks.
463	8	Sand	
475	12	Yellow clay	
493	18	Sand and gravel	
530	37	Hard pan and sand	Very hard streaks.
542	12	Sand	
602	60	Hard pan, clay, gravel, and cement	*Streaks very hard—water.
608	6	Yellow clay	
630	22	Hard pan, clay, gravel, and cement	Streaks very hard—water.
642	12	Sand	
648	6	Yellow clay	
650	2	Sand	

Stopped work for the present May 20, 1886.
* Water rose to within seven feet of surface.
No flow at above depth.
This well will be carried deeper within a few months. Say about August or September, 1886.

RECORD OF STRATA IN ARTESIAN WELL

Drilled by Geo. A. Raymond for J. B. Haggin, in Kern County, on Sections 29, 30, 31, 32, T. 30 S., R. 26 E., Mount Diablo Base and Meridian. Screw Casing 5 5-8 inches diameter.

Depth—Feet.	Thickness—Feet.	Character.	Remarks.
4	4	Dry sandy soil	
96	92	Quicksand	*First surface water.
98	2	Yellow clay	*No toughness or strength.
280	182	Quicksand and gravel	*Small streaks cement of no strength.
283	3	Blue clay	
340	57	Quicksand and gravel	†Small streaks cement and hard balls.
344	4	Blue clay	
374	30	Quicksand and gravel	†Hard balls.
376	2	Blue clay	
412	36	Sand and gravel	Hard streaks cement.
421	9	Blue clay	
432	11	Quicksand	
440	8	Blue clay	
460	20	Quicksand	Small flow water.
464	4	Blue clay	
472	8	Sand	Second flow water.
		Blue clay	Bottom of casing in blue clay.

Sufficient flow of water for two thousand head of stock.
*Equivalent to 280 feet of continuous quicksand, as the yellow clay was so thin and frail that it would not hold up the weight of the quicksand above.
†Samples of hard balls given to Mr. Hanks.
Well completed March 15, 1886.

Some of the specimens taken from the wells, I have examined microscopically and otherwise, and found exceedingly interesting, but to publish an account of them in their present unfinished condition would be premature.

MINERAL SPRINGS IN CALIFORNIA.

Numerous mineral springs are known to exist in California, some of which have gained celebrity, others are nameless and are only known by their localities. Some of the latter may eventually prove to be of great value. From the fact that it has been impossible to maintain a chemical laboratory in connection with the Mining Bureau, the official guide-book which was planned has not been made, and it has not been possible even to visit the most noted springs to study and publish their characteristics. The State Mineralogist has only been able to gather such information as could be easily obtained, and to condense it into the following list.

Among the many mineral products of the State the numerous mineral springs are not the least important. In Germany, Italy, Switzerland, England, France, Spain, Austria, Scotland, Ireland, Bohemia, and Portugal, in Europe, and New York, Virginia, Arkansas, Pennsylvania, West Virginia, Wisconsin, Kentucky, Ohio, Mississippi, Michigan, and Alabama, in the United States, and in Canada and elsewhere in the world, mineral springs are found. Mineral waters are generally divided into two principal groups—hot and cold. The principal subdivisions are—

Salt waters.	Alkaline waters.
Iron waters.	Mud springs.
Sulphur waters.	Alkaline saline.
Lime waters.	Magnesian.

A few more or less celebrated springs contain notable quantities of some special mineral or salt, to which they owe their peculiar character, as iodine, bromine, lithium, or fluorine.

California abounds in mineral springs more or less celebrated, but there seems to be no system in the use of the waters. People go to any spring which suits their taste or convenience, without knowing or seeming to care for the effect the water will have on them. This results from the fact that but few reliable analyses have been made, and physicians are at a loss how to prescribe for that reason. There should be an official guide book made by the State Mineralogist, which would be of very great utility to the State. Such a work would necessitate the establishment and maintenance of a very complete chemical laboratory, and the employment of able assistants. The following are the most important known mineral springs in the State. There are many others of less note, but which may be of equal and possibly greater value and importance. The late Dr. Hatch published the best account and description of the mineral waters of California, that has been previously written.

ALAMEDA COUNTY.

(1) *Piedmont Springs.*

Situated three miles from Oakland. As far as I am aware, no analysis has ever been made of the water of these springs, although they have attained considable celebrity.

CALAVERAS COUNTY.

(2) *Lane's Mineral Springs.*

These springs are located in the foothills of the Sierra Nevada, at an altitude of one thousand feet above sea level. They lie thirty-five miles east

of Stockton, from which place they may be reached by stage on alternate days; visitors are accommodated at a good hotel, besides which there are cottages for those who prefer them. The water in the springs is clear and cold, but no other information has been obtained, nor has any analysis been published as far as I know.

Colusa County.

(3) *Simmon's Hot Sulphur Spring.*

This spring is situated in Sulphur Cañon, but the exact locality is not given. The water has a temperature of 170°, but no analysis has been received.

(4) *Wilbur Hot Sulphur Springs.*

The route to these springs is by rail to Williams, and thence by stage. An analysis by an unnamed chemist has been published. It is claimed that the waters possess curative properties specially applicable to the treatment of rheumatism and cutaneous diseases.

Contra Costa County.

(5) *Byron Springs.*

There are said to be a number of springs at this locality, some of which are hot, while others are cold, some charged with carbonic acid gas, some with sulphuretted hydrogen. They are situated very near to Byron Station. There is a good hotel at the springs, and the accommodations are said to be first class. Trains leave San Francisco at 9 A. M. and 3 P. M., and Byron at 6:30 and 9:30 A. M. I have no reliable information as to the water of these springs, nor am I aware of any analysis having been made.

Humboldt County.

(6) *A very remarkable mineral water*

Has been discovered in a nameless spring in the town of Eureka. The water issues from the bank at the edge of the bay. At high tide the waters of the bay rise and cover the spring. The Indians knew of this spring and ascribed to it remarkable curative powers. It was rediscovered accidentally by a workman while the steamer Humboldt was being built near by. The water is now used in Eureka and San Francisco.

The following analysis, not before published, reveals the remarkable character of this water:

San Francisco, May 8, 1885.

Mineral water—one U. S. gallon.

Sodium chloride	1403.	grains.
Magnesium sulphate	211.3	grains.
Magnesium chloride	101.	grains.
Calcium sulphate	42.5	grains.
Sodium bromide	14.	grains.
Potassium sulphate	12.2	grains.
Sodium carbonate	10.1	grains.
Calcium carbonate	3.8	grains.
Alumina	1.3	grains.
Silica	.95	grains.
Carbonate of iron	.12	grains.
Manganese		Traces.
Boracic acid		Traces.
Iodine		Traces.
Lithium		Traces.

Contains a little carbonic acid, and is saturated with sulphuretted hydrogen. It is a sulphur, saline water, and should prove beneficial in affections of the glandular and lymphatic system, rheumatism, and diseases of the skin.

W. D. JOHNSON, M.D.

(7) *Felt's Springs.*

The following from the *Humboldt County Standard* contains all the information I have been able to obtain concerning these springs:

FELT'S SPRINGS.

Situated about twenty-five miles from Eureka, near the head of Strongs' Valley. Dr. Felt of Hydesville, the fortunate proprietor of these notable mineral waters, must eventually realize a handsome sum for his property. Some years ago he built a good private road from the public highway to the springs, laid pipe, concentrated the waters, cleared off some ten acres of the dense forest surrounding the springs, and erected on the opening a comfortable hotel, large barn, and other necessary improvements. The place was resorted to by many people, some for pleasure, others hoping to be benefited by drinking the mineral water, which it was well known possessed medicinal virtues of a high order. From the springs and thereabouts exudes a species of gas, which Dr. Felt collected in a primitive gasometer and utilized for the purpose of illuminating the premises, and it answered this end well. The waters have been found to be beneficial for persons afflicted with or having dropsical tendencies, many being entirely relieved who were affected in this way. About the time these springs were beginning to be appreciated on their merits, an unfortunate conflagration swept off the improvements. Since the fire the place has remained unoccupied as a public resort. We apprehend, however, upon the completion of the Eureka and Eel River Railroad, the present year (which passes within a short distance of the springs), they will again be opened for patronage.

ANALYSIS OF THE WATER.

From an analysis, made in San Francisco of a quantity of the water of Felt's Springs, it was found to contain the following substances: Carbonate of soda, carbonate of lime, a trace of iron, chloride of potassium, chloride of magnesium, carbonate of magnesia, carbonate of manganese, sulphate of potassa, and chloride of sodium. The location of this property is very picturesque, and its climate cannot be surpassed for salubrity, and with railroad communication it will make a delightful resort for the pleasure seeker as well as the invalid. There are plenty of trout in the streams and game in the woods and valleys.

Inyo County.

(8) *Owens' Lake.*

While the water of Owens' Lake is a mineral water in every sense of the word, yet it is not a mineral spring. It results from the evaporation of the water brought down by Owens' River, which enters the valley pure, but takes up in its long passage to the lake, soluble matter from the soil.

The mineral matter in solution in the waters of the river and lake is augmented by small salt and alkaline streams and the seepage from a multitude of mineral springs which abound in the foothills of the Sierra Nevada and the Inyo Mountains. The waters so extensively sold and advertised on the Pacific Coast and elsewhere under the trade name of "*Castalian*" is taken from this lake. The engraving on the circulars of this company is a deception, as it shows an imaginary spring on an isolated hill or mountain, from which a small stream is figured flowing down to the plain. The circulars claim that it is a natural mineral water from the Castalian Spring, Inyo County, which it is not. Owens' Lake is one of the most remarkable sheets of water in the world, and it is well worthy of a visit by tourists and Californians. Descriptions have been given of it in previous reports of this office. The waters are highly alkaline, remarkably dense, and in effect a nearly saturated solution of valuable salts, which will certainly be turned to account in the near future.

The waters of this lake have been analyzed by several chemists; a very full one by Thomas Price of San Francisco is published on the circulars

of the Castalian Company. The following is an approximate analysis by a London chemist by the name of Philips:

	Grains in an Imperial Gallon.
Chloride of sodium	2,942.15
Sulphate of soda	956.80
Carbonate of soda	2,914.43
Sulphate of potash	35.74
Silicate of potash	139.54
Organic matter	16.94
Pure water	2,994.40
	10,000.00

Owens' Lake may be reached by rail from San Francisco or Reno to Keeler Station, which is the present terminus of the road. The town is situated on the eastern shore of the lake.

(9) *Thermal Acid Springs.*

All the information this office has of these springs is contained in the following extract from the *Inyo Independent*, June 20, 1883:

These singular springs are situated in Inyo County, in the Coso Range of mountains, about sixteen miles southeast of Olancha Post Office. The springs have but a limited flow, and from crevices on the mountain side, through which steam is continually ejected, and thousands of tons of pure sulphur cover and surround the locality. The taste of the water is intensely sour, making it unfit for drinking purposes. It has no smell, but formerly there must have been large quantities of sulphureted hydrogen contained in it, as the sulphur deposit indicates. Large quantities of free sulphuric acid is found in the water, but the sulphur deposit, it is claimed by chemists, cannot be derived from this source. Chemists are at least unacquainted with a process by which free sulphuric acid would turn under the circumstances, such as the above, into sulphur. The composition is certainly a remarkable one, as will be seen from the following analysis. In one hundred thousand parts are contained parts:

Free sulphuric acid	78.4
Potassium sulphate	2.5
Sodium sulphate	15.1
Calcium sulphate	15.3
Magnesium sulphate	1.2
Aluminium persulphate	127.0
Iron persulphate	33.2
Nitric acid	Trace.
Chlorine	Trace.
Ammonia	Trace.
Lithium	Trace.

Springs or lakes of a chemical character like this are very rare; singular is also the small trace of chlorides in a water so strongly charged with mineral matters. The only known instance analogous to it is the Sour Lake in Texas, and a spring in the vicinity of the volcanoes in South American Cordilleros de los Andes.

Lake County.

(10) *Adams Springs.*

These springs are located in the pine mountains of Lake County, about eight miles south of Clear Lake, and two and a half miles from Siegler Springs, six miles from Harbin Springs, and twenty-eight miles from Calistoga. They are reached from San Francisco by rail to Calistoga, and thence by stage on alternate days. There is a good hotel at the springs. An analysis of the waters has been made, but the name of the chemist is unknown to me. The water is highly charged with carbonic acid gas, and is said to have a decided taste of petroleum. The waters are said to be good for rheumatism, and bilious diseases, and several cases of Bright's disease are said to have been improved by its use.

(11) *Allen Springs,*

Are located in a cañon near the head of Cache Creek, forty-five miles from Williams, which may be reached by rail from Sacramento. Communication between Williams and the springs is made by stage.

The waters of Allen Springs are cold, saline, highly charged with free carbonic acid gas, temperature 50°. An analysis made by W. T. Wenzell, whose name is a guarantee of its correctness, has been published.

(12) *Anderson's Springs.*

The character of these springs is hot sulphur and steam. They lie nineteen miles from Calistoga, and five miles from Middletown. There is a good hotel at the locality and a number of commodious cottages. No chemical analysis has been reported, and no further information obtained.

(13) *Bartlett Springs.*

These springs lie sixteen miles northeast of Clear Lake, in Lake county, and forty miles west of Williams, in Colusa county. They may be reached from San Francisco by rail to Calistoga, thence by stage. While no analysis has been published, the water is said to contain arsenic, by which reputed skin and other diseases are said to have been cured. The water is cold. It is largely bottled, and sold in San Francisco and elsewhere.

(14) *Bonanza Springs.*

There are several of these springs, about which, however, but little is known, aside from the fact that they are warm chalybeate; one is cold. There is also a cold plunge bath. No analysis has been made. Route from San Francisco is by rail to Calistoga, thence by stage to the springs.

(15) *Highland Springs.*

Situated twenty-five miles from Cloverdale, seven miles south of Lakeport, and four miles from Kelseyville, in sight of Clear Lake. Altitude, seventeen hundred feet. The springs are reached from San Francisco in ten hours by rail and steam to Cloverdale, thence by stage. There are several of the springs known by different names, as the "magnesia spring," the "magic spring," the "Dutch spring," and the "soda spring." The general character of the water may be learned by the following analysis:

Magic Springs, analyzed by Professor W. S. Rising, University of California. Temperature, 85°.

	Grains per U. S. Gal.
Chloride of sodium	1.290
Bicarbonate of potash	0.544
Bicarbonate of soda	21.763
Bicarbonate of lime	50.411
Bicarbonate of magnesia	70.243
Bicarbonate of iron	0.973
Bicarbonate of manganese	Trace.
Silica	7.398
Alumina	0.169
Organic matter	Trace.
Free carbonic acid	74.462
Total	227.253

BERKELEY, April 3, 1882.

The water from these springs has been bottled and sold in the State and elsewhere to a considerable extent.

(16) *Hot Borate and Ammonia Spring.*

This remarkable mineral spring is situated on the edge of Clear Lake near the Sulphur Bank Quicksilver Mine. An analysis made by Gideon E. Moore may be found in Geology of California, vol. 1, by J. D. Whitney, folio. The water is remarkable as containing large quantities of potassium, ammonia, bromine, and borax. The waters have been used medicinally, but as yet to no great extent.

(17) *Hough's Mineral Spring.*

This spring, of which but little is known, is reached by stage from Williams in Colusa County, by which daily communication is made.

(18) *Howard Springs.*

Located five miles from Adams' Springs, one and one half miles from Siegler Springs, and five miles north of Harbin. Altitude, two thousand two hundred and twenty-five feet. May be reached from San Francisco by Napa Valley Railroad to Calistoga, thence by stage. There is a good hotel at the springs, and commodious cottages. There are said to be fourteen springs, hot and cold; temperature from 58° to 109°. One spring is chalybeate, one is cold, sparkling, and highly charged with carbonic acid gas. No analysis reported. Information as to the character of the water of this spring to be obtained without an actual visit to the locality is meager and unsatisfactory.

(19) *Iodine Spring.*

In April, 1872, a remarkable mineral water was examined by Falkenau & Hanks of San Francisco, which was found to contain considerable iodine. Information has since been obtained to the effect that the spring is situated at the entrance of Grizzly Cañon, Lake County, five or six miles from Wilbur Springs. This subject has been alluded to in the fourth annual report of this office, folio 230.

(20) *Saratoga Springs—formerly Pierson's.*

Situated fourteen miles from Lakeport, one mile west of Witter Springs. They may be reached from San Francisco by rail to Calistoga, thence by stage to Lakeport and the springs. There is a good hotel and accommodations. The springs, of which there are several, are cold. The waters are sulphurous and alkaline, containing, it is claimed, sulphur, soda, iron, magnesia, and free carbonic acid gas. No analysis is reported. It is claimed that a multitude of diseases are cured or ameliorated by the use of the waters.

(21) *Siegler Springs (hot and cold).*

These somewht celebrated springs are situated in a cañon, said to have an elevation of two thousand five hundred feet. There is at the locality a good hotel and accommodations. The waters are alkaline and chalybeate. One spring is said to contain arsenic, and to be valuable for the

treatment of chronic cutaneous diseases. An analysis of the waters is reported, but as far as can be learned it has not been published.

These springs are reached by stage from Calistoga. Time from San Francisco, twelve hours.

(22) *Witter Springs.*

These springs are situated in the Coast Range of mountains, five miles from the town of Upper Lake, and fifteen from Lakeport, near the Blue Lakes. There are several springs which are cold. They are alkaline, sulphurous, and have considerable reputation as yielding healing waters. There is a good hotel on the grounds, and a number of commodious cottages for visitors. No analysis has been published.

Lassen County.

(23) *Big Hot Springs.*

This spring lies about three miles north of Honey Lake. The exact locality is section twenty-three, township twenty-nine north, range fifteen east, Mt. Diablo meridian. It is called a boiling spring, which it practically is, its temperature being 200° F. The water rises with considerable force from an orifice equal to a foot square. From observations made by John Pfeninger, from a spout 4x18 inches, forty-five cubic inches flowed in one minute. The chemical character of the water is not known, as no analysis has been made. No medicinal properties are yet claimed for it.

Los Angeles County.

(24) *Fulton's Sulphur Wells.*

These artificial flowing wells yielding a mineral water claimed to be valuable, lie two miles north of Norwalk Station, on the Los Angeles and Anaheim railroad. An analysis is published in a circular issued by Dr. J. E. Fulton, from whom the wells are named. This shows the water to contain bi-carbonate of soda, lime, magnesia and iron, sulphate of soda, chloride of sodium, silica, traces of iodine and potash, and free carbonic acid, hydrosulphuric and nitrogen gases. The water flows from two wells three hundred to three hundred and fifty feet deep. The water is cold. There is a good hotel on the grounds, and good accommodations for visitors. A daily stage connects with the railroad at Norwalk.

Mendocino County.

(25) *California Seltzer Spring.*

This valuable spring I visited personally, and the following is the result of my observations. Analysis have been made and published by J. A. Bauer, Louis Falkenau, and by myself:

The spring is situated in Mendocino County, about one and one half miles from the Fountain House, which is twelve miles from Cloverdale, on the Ukiah road.

The distance from Cloverdale to the spring in a direct line is nine miles, and the direction, north forty-two degrees west.

The exact location may be stated as follows: It is on the southeast quarter of the northeast quarter of section five, township twelve north, range eleven west, Mount Diablo base and meridian.

The spring lies in a beautiful and picturesque valley, and the mountain scenery surrounding it is charming. A small frame building has been erected over the spring to protect it from the sun and rain. The water flows from a half-inch pipe, and I am informed by those who reside near the spring that the flow is continuous and equal throughout the

year. By careful experiment I found the discharge from the pipe to equal 45.89 wine gallons per hour, or 1101.36 gallons in twenty-four hours.

There are several points in the cañon where the same water issues from the ground, which is allowed to run to waste, all of which could be saved and turned to account.

When drawn from the spout, the water is cold, having a temperature of 61° Fahrenheit. At the time the temperature was taken that of the room was 98°.

The water, to the taste, is very agreeable. It contains such an excess of carbonic acid that that gas is continually being given off, like champagne. Carbonic acid gas is also continually bubbling up from the pool into which the water falls from the spout.

When first drawn the water is perfectly clear, but soon assumes a faint opalescence, and after standing for some time it lets fall an inconsiderable precipitate. At the exit there is a large deposit of a red sediment, which is seen on the sides of cisterns into which the water flows, and also on the stones in the bed of the stream.

The water does not act on all persons drinking it alike. To some it is a gentle cathartic, while others are not so affected.

When the water is shaken in a vessel there is a sudden evolution of free carbonic acid gas. When first drawn the water gives an acid reaction, owing to the carbonic acid; but after standing for some time, or after boiling, it becomes alkaline.

A large proportion of the solid constituents are held in solution by the free carbonic acid; these become insoluble, and precipitate, when the water is boiled.

The total solid constituents of the water in a wine gallon, obtained by evaporating that quantity of the water to dryness in a silver dish, was found to be 181.2311 grains.

Mono County.

(26) *Mono Lake.*

A wide spreading sheet of mineral water lies in Mono County, and is one among the many natural curiosities of our noble State, which should be more generally visited by tourists, which is now no hardship, as a first class narrow gauge railway runs within a short distance from its shores. This lake, which is more correctly an inland sea, resembles in many of its features the Dead Sea of the Holy Land. The same may be said of Owens' Lake, a description of which will be found in its proper place.

Mono Lake lies in a depression, in an extensive desert basin, which was probably in ancient times an extensive volcanic crater, and from which can be traced streams of ancient lava, which flowed in several directions.

The lake is fourteen miles, more or less, from east to west, and nine from north to south, but it varies in size, owing to temperature and the quantity of snow that falls during any year on the summits of the adjacent Sierras. When an unusually large quantity of snow falls the waters expand, and for the same reason they become more dilute. When the conditions are different the waters of the lake evaporate, and it shrinks. The waters becoming in proportion more dense and highly charged with salts, this fluctuation is marked on the shore by an amphitheater of low terraces.

At one time the lake was much larger than at present, as shown by magnificent terraces at a greater distance from the shores. The water derives its salts from rivers or creeks that flow into it. These collect from the volcanic soils the soluble parts, which they deposit in the lake. Having no outlet, the basin retains it, and by evaporation it becomes condensed. During a period of probably many centuries this lake has stored up vast quantities of valuable salts, which await the hand of man to gather and utilize.

These waters are intensely saline, but their exact constituents are not yet known; a careful and exhaustive analysis has been commenced by the Mining Bureau, the results of which will, no doubt, be duly published.

There are several islands in the lake, on one of which there are hot and mineral springs, a feeble remnant of the volcanic activity of former days. A few miles from the margin of the lake, may be seen several volcanic cones, expired years ago, but which have left lava and obsidian as a

memento of past volcanic energy. Great quantities of gulls and other aquatic birds flock to the shores of the lake to feast on the larvæ which abound in its waters.

The presence of worms and minute and curious living forms in the highly alkaline waters of the lake, is a striking example of nature's care for animal life. How these creatures can live in a solution so alkaline that it will attack the flesh of a human being, is one of the mysteries of the universe.

The water sent down to the Mining Bureau has been placed in a large vessel of crystal glass, and is now on exhibition in the Museum. When first received, on looking through it, one could see a number of strange animals swimming about in full possession of life and happiness; although preferring to swim on their backs, their motion resembled that of the oars of a Venetian gondola, or of the argo, as described in mythological fable. Yet, when the bottle is gently shaken, the water strikes against the sides of the vessel containing it like oil, or concentrated sulphuric acid. When evaporated this extraordinary water leaves behind a white saline mass equal to 2926 grains in an imperial gallon.

There is in my mind no finer view in the State than of the valley or desert in which Mono Lake lies, with the White Mountains for a background, as seen from the summit of Mono Pass. It is only a short distance from the Yosemite, which is visited by thousands of tourists annually. The route is by Lake Tenaya, Cathedral Peak, Tuolumne Valley, the Soda Springs, and the most romantic and highly interesting Mono Pass and Bloody Cañon. It is strange that more tourists do not avail themselves of the opportunity to visit these interesting localities.

The larvæ in the lake are thrown up by the sluggish waves, and accumulate in enormous quantities. They are gathered by the Indians and dried for food. To them they are as delightful a refection as locusts and wild honey of Bible fame.

The mineral salts contained in this vast depository should and will be utilized at no distant day. The reaction for boracic acid is so decided that it is almost safe to predict that crystals of borax will eventually be found in the mud at the bottom of the lake, as at Borax Lake, in Lake County, and it is to the interest of the State that an exhaustive analysis should be made of the waters.

The following analysis of Mono Lake water, by J. R. Murphy, was copied into the *Mining and Scientific Press*, vol. 12, fol. 59, from the *Reese River Reveille*:

Acids Present.

Quantitative.

Boracic	Large traces.
Carbonic	Abundant (free?).
Hydrosulphuric	Abundant (free?).
Phosphoric	Traces.
Silica	Traces.

Quantitative.

Chloride of sodium	5.854.
Chloride of potassium	1.581.
Chloride of calcium	2.630.
Chloride of magnesium	8.206.
Sulphate of lime	.402.
Sulphide of calcium	Traces.
Sulphide of magnesium	Traces.
Water	81.327.
Total	100.000.

Nameless Mineral Spring.

Near Bridgeport. This spring, represented in State Museum by No. 1,576, has deposited a very large quantity of aragonite or calcite.

Monterey County.

(27) *Paraiso Hot and Cold Mineral Springs.*

These springs are situated six miles from Soledad, one hundred and forty-three miles from San Francisco, on the Southern Pacific Railroad; a stage connects daily with the station. There is a good hotel on the grounds and twenty-five two-story cottages. The altitude is said to be 1,200 feet above the valley. The waters flow from a number of springs which have the same general character, as shown in the following analysis made by a well known and reliable chemist:

Chemical Laboratory, Santa Clara College, S. J.,
Santa Clara, California, November 25, 1871.

Mr. Pedro Zavala: Your sample of water having been duly analyzed in our chemical laboratory, gave the following result: In one gallon of water were found—

	Grains.
Matter volatile on ignition, so called organic matter	5.25
Silica	2.62
Alumina and iron	1.60
Magnesia	Trace.
Chloride of potassium	0.35
Chloride of sodium	3.50
Sulphate of soda	35.50
Carbonate of soda	4.23
Sulphate of lime	4.32
Carbonate of lime	1.43
Total	58.80

Yours respectfully,

A. CICHI, S. J., Professor of Chemistry.

P. S.—The water contains 35.50 grains to the gallon of sulphate of soda. This sulphate of soda (written otherwise Glauber's Salt) is used universally as a cathartic.

Napa County.

(28) *Calistoga Thermal Springs.*

These springs are in the town of Calistoga within a few minutes walk of the terminus of the Napa Valley Railroad. There are a number of them, all of which are warm; some very hot. Over the principal spring now stands a small, dilapidated, wooden building with no doors or windows. The spring from which steam escapes continually, is boxed up with boards; the box is about two feet square. The temperature of a bucket of this spring freshly dipped up when I visited it, was 196° F. by two observations, carefully taken. The temperature of the air was 86°. The water that overflows heats the surface water outside the building to 120°. The water in a small creek near by was 92°. The temperature of the old mud-bath was found to be 104°, and the spring that feeds it 148°. The plunge-bath spring was 132°, and the spring that supplies the bath house 173°. The chicken-soup spring had a temperature of 154°, and the water pumped up for baths at the Magnolia Hotel at Calistoga was 102°. The waters are used both for bathing and for drinking, but an analysis was made by J. T. Rudolph of Sacramento, and published in Dr. Hatch's report, showing that, with the exception of the rather large quantity of free hydrosulphuric acid, they contain no elements likely to give them much reputation for medicinal

virtues. But there is no locality that I know of in California where such facilities are found to make a delightful place of resort. The heat of the water, now going to waste, could be employed in manufacturing, specially for fruit drying, or conducted in pipes, would impart vitality to tropical plants. Conservatories so heated could be made to vie with the celebrated palm houses of Kew Gardens in London. Calistoga is a beautiful place, situated in a most delightful locality. With a judicious outlay of capital and labor, directed by men of taste, judgment, and ability, the grounds upon which these springs lie could be made an earthly paradise.

The springs seem to originate at the base of a conical mound or butte which rises on the grounds to an altitude of from seventy-five to eighty feet, which tends to give a landscape garden aspect to the grounds.

There are good hotels in Calistoga, and on the grounds there are a number of roomy cottages for the use of visitors; in front of each is a large palmetto tree which gives a tropical appearance to the grounds. At the time of my visit, all were deserted. The *chicken soup spring* is in no way entitled to the name. It is a trick of those interested, to take up a dipper of the water and to add pepper and salt, which, to a person of active imagination, does have somewhat the taste of soup. My experiments show that any warm water so treated has the same taste, and that it is to the pepper and salt and not to the water that the taste is due.

(29) *Ætna Springs.*

I visited these springs in September, 1881, having been at the same locality when it was being worked as a quicksilver mine, a number of years before.

These springs lie in a small depression at the northern end of Pope Valley. The exact locality is sections one and two, township nine north, and range six west, Mount Diablo meridian. The altitude is said to be one thousand feet, but by barometer it seemed to be only seven hundred and sixty feet. It is fifteen miles east of St. Helena.

There are two springs which discharge a large quantity of water; one is from the old mining shaft of the Valley Quicksilver Mine. The shaft is one hundred and twenty-five feet deep. The Valley Mine was incorporated in 1867, certificate filed May sixteenth. The company made the serious mistake of sinking the working shaft in the bed of the creek, which necessitated costly pumping apparatus, and in the winter the mine was flooded by the waters of the creek. There was also much trouble caused from emanations of carbonic acid gas in the workings. At one time considerable ore was extracted, but owing to the difficulties the yield was but small.

The springs have gained quite a reputation. The number of visitors is given below for four years:

1878	300
1879	600
1880	900
1881	1,200

A full analysis of the water was made by Edward Booth, chemist of the State Mining Bureau, which is published in the second annual report of this office, folios 10 and 11. An analysis made by A. J. Bauer was published in Dr. Hatch's report. The water is perfectly clear; at the time of my visit, the temperature was 98°, that of the air being 78°. The first taste is pleasant but peculiar, and sparkling as if containing much carbonic acid gas. Both springs deposit ferruginous matter and in the dry bed of the

stream drop an alkaline incrustation. There is a distinct alkaline smell at both springs. When shaken in a bottle gas escapes. There is also a decided smell of hydrosulphuric acid when so shaken.

In one spring large bubbles of carbonic gas rise to the surface, and in a pool in the creek bed a constant bubbling takes place.

On the grounds there is a commodious hotel, and cottages for the use of visitors. The valley is warm and dry and the mountain scenery charming.

Much is claimed for the curative properties of the waters of these springs, with what truth I am unable to say.

(30) *Harbin Springs,*

Lie twenty miles more or less from Calistoga. They are reached by stage from the station. There are numerous springs. The temperature of the principal one is 118°. The waters are sulphurous and chalybeate. No analysis has been published. The springs have a good reputation and many visitors. The accommodations are said to be good. As usual in California, cottages are provided for the convenience of those who prefer them to the hotel.

(31) *Kellogg Springs.*

They lie near Calistoga. I have no other information concerning them that is reliable.

(32) *Napa Soda Springs.*

These are the oldest and the best known of any California mineral springs. For many years the waters have been bottled and sold all over the Pacific Coast. They lie on the slope of the mountains east of Napa Valley, and seven or eight miles north of Napa City. An analysis of the waters made by Dr. L. Lansweert, in May, 1856, has been published in Dr. Hatch's report. The buildings and accommodations for visitors are the most numerous and extensive of any in the State.

(33) *White Sulphur Springs.*

These springs, which lie only two miles from the Town of St. Helena, have become a fashionable and elegant place of resort. There is a good hotel, beautiful grounds, and cottages for the use of visitors. There are nine springs, having a temperature from 65° to 89° F. Analyses of three of them, made by Professor Le Conte of the University of California, have been published in the report of Dr. Hatch. The waters are used both externally and internally.

PLACER COUNTY.

(34) *Cornelian Hot Springs*

Lie on the margin of Lake Tahoe. There are several of them, hot and cold. The waters are used principally for bathing. They are said to be very efficient in the treatment of rheumatism and neuralgia. The springs are reached by railroad to Truckee, thence by stage. There is a good hotel and accommodations on the grounds. As far as I have been able to learn, no analysis has been made.

(35) *Summit Soda Springs.*

Situated twelve miles from Soda Spring Station, on the Central Pacific Railroad; thence by stage to the valley in which the springs lie. The

altitude is said to be six thousand and nine feet. The waters are alkaline, with an excess of free carbonic acid gas. An analysis, made by J. F. Rudolph of Sacramento, has been published in the report of Dr. Hatch.

San Bernardino County.

(36) *Arrowhead Hot Springs.*

Located ten miles from Colton and six miles northeast of San Bernardino. Altitude over two thousand feet. First came into notice in 1858. It is claimed that the waters and climate will cure consumption. One spring actually boils, having a temperature of 210° F. An artificial pond for bathing has been prepared, the dimensions of which are one hundred by seventy-five feet. There are mud baths, also, which are deemed of great use in cutaneous diseases. No analysis has been published.

Anti-Fat Spring.

Situated twelve miles from Temescal, on the Santa Ana River. A sample of the water was brought to the State Mining Bureau and was entered on the catalogue No. 1,577. There being no laboratory, no analysis was made. The name indicates what is claimed for the water.

(37) *San Bernardino Hot Springs.*

These waters gush out from crevices in granite. Sufficient water flows from them to raise the temperature of a small stream near by to 130° F. The water so heated is ample to constitute an efficient water power. It would not be a new thing in California to see a mill wheel turned by hot water. There is a large hot spring near Blind Springs, in Mono County, which cannot, however, be classed as a mineral spring, which actually drove a quartz mill for several years. I have seen this myself. The water was scalding hot.

The San Bernardino Hot Springs are calcareous and form a deposit or incrustation on twigs and pebbles which is snow white. The temperature is from 108° to 172° F. The altitude of the springs is said to be sixteen hundred feet. No analysis of the waters has been made.

San Diego County.

(38) *Aqua Caliente. Thermal Sulphur Springs.*

These springs are on Warner's ranch, fifty miles from San Diego. There are at least seven springs, varying in temperature from 58° to 142° F. They flow from small openings in a ravine, formerly the bed of a brook now diverted. Bubbles of sulphuretted hydrogen are continually escaping. The water, highly charged with this gas, has a pleasant acid taste. At one orifice a jet of steam issues with a hissing sound. No analysis of the waters has been made. Cures are claimed for dropsy, rheumatism, and cutaneous diseases. At last accounts these springs were in possession of a band of Indians, who let adobe huts or cottages to visitors.

There are other mineral springs in this county, near Elsinore. The following, from the San Diego *Union*, is all the information I have been able to gain:

> A wonderful little valley running through the town site, containing mineral springs of hot and cold water, sulphur, soda, white sulphur, magnesia, iron, borax, hot mud, fresh water, etc.—one hundred and eighty-six in number.

San Luis Obispo County.

(39) *Arroyo Grande Warm Springs.*

These springs are located fourteen miles south of San Luis Obispo, and fifteen miles from Port Harford, by which they are in communication by daily stage. Port Harford is reached by steamer from San Francisco. There are good accommodations to be obtained at all times. As in the case of all other mineral springs in the State, it is claimed that a large number of diseases are cured by the use of the waters.

(40) *Big Sulphur Spring.*

Of which nothing more is known, lies in section thirty-six, township thirty-two south, and range twenty-one east, M. D. M.

(41) *Bitter Water Spring.*

A spring so named is located in section four, township thirty-two south, range eighteen east. No further information has been obtained.

(42) *Black Sulphur Spring.*

Is situated in the same section.

(43) *Cameta Warm Springs.*

Lie in township twenty-nine south, range seventeen east, M. D. M. I have no other information concerning them.

(44) *Iron Mineral Spring.*

Located near the Huero-Huero Rancho, on section twenty-five, township twenty-eight south, range fourteen east, M. D. M. It is said to belong to a company, and to have much value as a curative agent.

(45) *Anonymous Mineral Spring.*

Township thirty south, range fourteen east, M. D. M. No other information obtained.

(46) *Newsom's White Sulphur Springs.*

Located fourteen miles, in a southerly direction, from the city of San Luis Obispo, and twelve miles southeasterly from Port Harford, and two miles from the Arroyo Grande stage station. This would place them near No. 39. They are within six miles of the ocean beach. Much is claimed for the medicinal virtues of these waters, and they are said to be a sure cure for nasal catarrh. There is a hotel on the ground and cottages for the use of visitors. This spring is represented in the State Museum by No. 1,572.

The five following springs, which are not yet named, are in the same neighborhood, are also represented in the State Museum. The catalogue numbers are also given:

(47)—1570—*Mineral Water.*

Spring No. 1, Cuesta Ranch, northwest quarter of the southwest quarter of section seven, township thirty south, range thirteen east, Mount Diablo meridian.

(48)—1571—*Mineral Water.*

Spring No. 2, Cuesta Ranch, northwest quarter of the southwest quarter of section seven, township thirty south, range thirteen east, Mount Diablo meridian.

(49)—1573—*Water.*

From the Arroyo Grande Warm Springs, sulphur water No. 2, Santa Manuella Rancho.

(50)—1574—*Water.*

From the Arroyo Grande Warm Springs, sulphur water No. 3, Santa Manuella Rancho.

(51)—1575—*Mineral Water.*

Arroyo Grande Warm Springs, sulphur water No. 4, Santa Manuella Rancho.

(52) *Paso Robles Thermal Sulphur Springs.*

Located twenty-three miles very nearly north of San Luis Obispo, township twenty-six south, range twelve east, Mount Diablo meridian. These springs have a widespread reputation, not only for the medicinal properties of the waters, but also for the fine climate and beautiful surroundings. They lie in a natural grove of oaks, from which the name is derived. There is a good hotel, and the best of accommodations to be had. There are several springs having a temperature of from 110° to 140° F. The waters are used for drinking and bathing. When largely used they are laxative, otherwise tonic, and are specially recommended for rheumatism, malarial affections, and cutaneous diseases. Two analyses have been published in the report of Dr. Hatch, one from a clear thermal spring and one of a mud bath. The name of the chemist is not given. The water is charged with gas. About the principal spring an inclosing wall of freestone has been built. The water is clear, but smells strongly of hydrosulphuric acid gas. The water of some of the springs is nearly cold. The mud baths are artificially prepared.

Santa Barbara County.

(53) *Santa Barbara Hot Sulphur Springs.*

Altitude, about one thousand five hundred feet. There are seven springs at the locality, nearly all of which are of the same general character. They are said to contain free sulphur (if so it must be held in suspense), and an excess of hydrosulphuric acid (sulphuretted hydrogen). Temperature, from 114° to 117° F. The waters are held in high esteem for the cure of cutaneous diseases, rheumatism, and paralysis. An artifical bath has been constructed, which is deep enough for a plunge. The springs are accessible by steamer to Santa Barbara; thence by stage. Distance, about five miles. No analysis has yet been made of the water. A thick incrustation of sulphate of alumina forms at the outlet of one of these springs.

SANTA CLARA COUNTY.

(54) *Gilroy Hot Sulphur Springs.*

These springs are situated twelve miles east of Gilroy, from which they may be reached by stage. There is said to be but one principal spring, located near Coyote Creek. The water is clear and hot. It is used both for bathing and drinking. There is a good hotel at the springs, which affords excellent accommodations. No analysis has been published, to my knowledge.

(55) *Alum Rock Sulphur Springs.*

Situated in Penitentiary Cañon, seven miles from San José. The character of the springs is given as sulphur, soda, and salt springs. The temperature is 85°. A partial analysis has been published in Dr. Hatch's report. There is a good hotel at the springs, and good accommodations. From San Francisco these springs may be reached by rail to San José; thence by stage.

(56) *Pacific Congress or Saratoga Springs.*

Locality in the Coast Range, ten miles west of Santa Clara. The water is quite extensively bottled and sold in the State. The springs are chalybeate and alkaline. If the water is freely used it acts as a purgative, otherwise the effect upon the system is tonic. Two analyses have been made—one by J. A. Bauer, and one by James Howden, which are published in the report of Dr. Hatch. The best of accommodations at the hotel or in cottages, according to the taste or desire of visitors. The springs may be reached by rail to Los Gatos; thence by stage.

(57) *New Almaden Vichy.*

This spring has long been known. It is situated near the New Almaden Quicksilver Mine. Many years ago the waters were largely bottled and sold. It was specially a favorite with the French population. An analysis by E. Pique, of San Francisco, was published as an advertisement by those who made a business of the sale of the water. The analysis is given below:

One bottle (two pounds) contains one hundred and eight grains and sixteen hundredths of solid matter, as follows:

Acide carbonique (carbonic acid)	28.02 grains.
Bi-carboate de soude (bi-carbonate of soda)	50.03 grains.
Bi-carbonate de chaux (bi-carbonate of lime)	8.00 grains.
Oxyde de fer (oxyd of iron)	1.02 grains.
Sulfate de chaux (sulphate of lime)	10.05 grains.
Sulfate de magnésia (sulphate of magnesia)	3.00 grains.
Chlorure de sodium (chloride of sodium)	8.04 grains.
Silice (silica)	Traces.
	108.16 grains.

It is claimed these waters possess curative properties in case of rheumatism and gout, and to be a valuable tonic. It is curious to note that an unusual number of the best mineral springs in the State are in the near vicinity of quicksilver mines.

(58) *Magnetic Mineral Spring.*

Near Watsonville; no reliable information could be obtained concerning this spring without a visit to the locality.

Shasta County.

(59) *Soda Springs.*

These springs are situated in the cañon of the Sacramento River at an elevation of two thousand three hundred and sixty-three feet. The waters are chalybeate. As they run from the springs they deposit an extensive bed of iron. There is an excess of carbonic acid gas in the waters, which are cold; temperature, 52°. They may be reached from San Francisco by rail to Redding; thence by stage. The locality and the springs are described in Geology of California (Whitney), vol. 1, folio 332.

Solano County.

(60) *Tolenas Spring.*

Situated five miles north of Suisun. The waters are saline alkaline, but in the absence of any analysis no further information can be given. The water has, to a limited extent, been charged with carbonic acid, bottled, and sold. The spring may be reached from San Francisco by rail to Suisun, and thence by stage or private conveyance.

(61) *Fairmont Mineral Spring,*

On Whitman's Ranch, four miles east of Cloverdale. No analysis has been made that I can obtain information of.

(62) *Litton Seltzer Springs.*

These justly celebrated springs are situated near Healdsburg; the waters contain carbonated alkali, and an excess of carbonic acid gas. They are pleasant to the taste, and many cures are accredited to their use. The water is largely bottled, and sold in this city and State. There is a good hotel, and first class accommodations on the grounds, which are near a railroad station. When freshly drawn, the water is slightly acid; after standing, it becomes alkaline. One wine gallon contains 228.69 grains of solid constituents, which consist of the following:

Acids.	Bases.
Boracic.	Alumina.
Carbonic.	Ammonia.
Hydrochloric.	Iron.
Sulphuric.	Lime.
Silicic.	Silica.
	Magnesia.
	Potash.
	Soda.
	And organic matter.

There is a large quantity of free carbonic acid which escapes on standing. The water in the spring is abundant. When it is required in bottles it is forced into a receiver with considerable pressure, from which it is drawn into bottles and quickly corked. No carbonic acid gas is added artificially to the water.

(63) *Geyser Spa or Geyser Soda Spring.*

This spring is situated four miles from Geyserville, and very near the Litton Springs (No. 62). Large quantities of the water is bottled and sold in the city and State. There are agencies also in Sacramento, Oakland,

Santa Rosa, and San Rafael. These waters were thus sold twenty-four years ago. The business was resumed last November. An analysis published by Dr. Hatch in his report shows the water to be very nearly identical with that of Skaggs Spring.

(64) *Mark West Hot Sulphur Spring.*

Located eight miles from Santa Rosa on the road to Cloverdale, township eight north, and range eight west, by Bancroft's map. Beside the hot spring there are cold sulphur and iron springs. No analysis of the waters have been published. There is a good hotel and cottages on the grounds which furnish first class accommodations.

(65) *Skaggs Springs.*

Located eight miles southwest of Geyserville, in township ten north, range eleven west, Mount Diablo meridian. There are two springs of hot water, and a cold soda spring. The principal spring is situated in the bed of a dry creek. The temperature is 130° to 140° F. An analysis by Professor E. W. Hilgard, of the University of California, has been published. Besides those mentioned above there is a chalybeate well. A good hotel and commodious cottages offer ample and excellent accommodations. The waters are recommended for neuralgia, rheumatism, sciatica, dyspepsia, and chronic diseases of the kidneys.

(66) *Geysers.*

The group of mineral springs known by this name, of which there are three hundred in number, covering an area of one thousand acres, are counted among the natural wonders of California. The altitude is given as one thousand nine hundred feet above sea level. Some of the springs are hot, others cold. One blows off steam like the escape pipe of a steamboat, from which it takes the name of the "Steamboat Geyser." The springs were discovered in 1847, since which they have been visited by many persons. No sufficient analysis or analyses have ever been made of the waters of these springs, nor have the waters ever been bottled for sale. The springs are situated on the Pluton River, which empties into Russian River, near Cloverdale.

There are two routes to these springs. By rail, either to Cloverdale or Calistoga, and thence by stage. There are ample hotel and bathing accommodations. The temperature of the springs, of which there are three classes—aluminous, sulphurous, and chalybeate—is from 200° to 210° F.

(67) *Santa Rosa White Sulphur Springs.*

They lie only two miles from Santa Rosa. Hot and cold sulphur baths are offered to visitors. No further information has been obtained.

TEHAMA COUNTY.

(68) *Tuscan Springs.*

Lie in section thirty-two, township twenty-eight north, range two west, nine miles from Red Bluff. There are three principal springs of *cold sulphur waters.* The water for bathing is heated by burning the carburetted hydrogen gases given off by the springs. The temperature of

three springs is thus given: Black sulphur, 68° F.; white sulphur, 70° F.; red sulphur, 80° F. The waters are said to contain large quantities of iodine, lithium, and of potash, and to be effective remedies in treatment of rheumatism, cutaneous diseases, and intermittent fevers. They are said also to resemble the Blue Lick waters of Kentucky.

(69) *Lick Spring.*

This is one of the Tuscan Springs (No. 68), which was discovered by Dr. John A. Veatch in January, 1856, in what was then Shasta County. The subject is referred to on folio 15 of Part II, third annual report of this office, 1883. An analysis was made by Dr. L. Lanszwert and published by Dr. J. B. Trask, first State Geologist, in his report of 1856, folio 61. By referring to this analysis it will be seen that it was of a most surprising nature, but Dr. Veatch states that it is unreliable. Still, the practical results obtained were very extraordinary. In January, 1856, Dr. Veatch, while evaporating the water in course of a chemical examination, obtained several pounds of borax crystals, which were deposited in the museum of the California Academy of Sciences, where they probably still remain. This was the first borax known to exist on the Pacific Coast. By a reference to the former reports of this office it will be seen how important that discovery really was.

Tuolumne County.

(70) *Cold Soda Spring.*

This very important mineral spring, which I have visited, is situated in Tuolumne Valley, on the Mono trail from the Yosemite to Mono Lake. It is located on Holt's map in township one south and range twenty-four east, M. D. M. The water is cold, sparkling, and delightful to the taste. The surroundings are charming. No analysis has, to my knowledge, been made of the water. At some not very far distant time this will become a favorite place of resort.

CALISTOGA SILVER MINES.

For many years indications of silver have been found in the vicinity of Calistoga, in Napa County. The hot springs described elsewhere are evidences of active solfatara, which elsewhere in the State have produced mineral veins of greater or less value. In the strata exposed by the upheaval of Mount St. Helena, there are veins or deposits which are without doubt the result of solfataric action. Silverado, on the mountain above the toll house, was at one time the scene of considerable mining excitement. A mill was erected and much work done on the mine. While it is claimed that considerable silver was extracted from the ores, it has never been shown by figures that this was the case. Some years ago, but after the mine was abandoned and while the mill stood idle, I examined very closely some ore left on the platform, and found it to be very poor, from which I drew the inference that work was discontinued because the ores were practically worthless.

Afterwards, in 1865, I again visited the locality and made a very careful examination of the ore on the dump and in the workings of the Venus Mine at Silverado. My impression was that as far as developed the ores

were of very low grade, but from indications ore bodies of some value might eventually be discovered. The following is the result of an assay of sample of ore from this locality:

CALIFORNIA ASSAY OFFICE, WM. IRELAN, JR., ASSAYER AND CHEMIST.
ROOMS 47, 48, AND 49 MERCHANTS' EXCHANGE, SAN FRANCISCO, September 5, 1885.

Memorandum of assay of ores made for H. G. Hanks, State Mineralogist, of ores marked "Dump, Calistoga or Venus Mine," and "Average from Calistoga—Museum No. 6,518."

Dump, Calistoga or Venus Mine.

Silver, per ton	Troy ounces, 2.18
Gold, per ton	Troy ounces, 0.03

Average from Calistoga—Museum No. 6,518.

Silver, per ton	Troy ounces, 4.37
Gold, per ton	Troy ounces, 0.15

Respectfully submitted.

WM. IRELAN, JR.

I afterwards visited the Grizzly Mine, near the town of Calistoga, and was surprised to find a considerable quantity of good ore taken out, some of which was very rich, as may be seen by the following assay of sample brought to San Francisco and placed in the State Museum:

CALIFORNIA ASSAY OFFICE, WM. IRELAN, JR., ASSAYER AND CHEMIST,
ROOMS 47, 48, AND 49, MERCHANTS' EXCHANGE, SAN FRANCISCO, August 27, 1885.

Memorandum of assay of ore made for Henry G. Hanks, Esq., State Mineralogist.

Silver, per ton	Troy ounces, 514.79
Gold, per ton	Troy ounces, 0.5

Respectfully submitted.

WM. IRELAN, JR.

This result is very remarkable, and seems to justify the hope that valuable if not extensive silver mines may yet be found at this locality. The Calistoga Mining District is situated in section twenty-four, township nine north, range seven west, M. D. M. The altitude of the Grigsby Mine is two hundred and sixty feet above Calistoga, or five hundred and ninety-one feet above sea level. The Ida Easley Mine is still higher, but in the same district. This mine is not yet worked to any great extent. It would be hard to predict what developments may yet be made at this very interesting locality.

The little hill, or butte, at the thermal springs, mentioned elsewhere, is an outlier of the mountains which contain the silver ores.

ARROW MINING DISTRICT, SAN BERNARDINO COUNTY.

A new gold and silver district has recently been brought to notice, located and named as above. The name is derived from the arrow weed springs, so called, because they furnish the Indians with rush-like stems, which grow in abundance on the margin of the springs, and which they use for the shafts of their arrows. The district lies about twenty-eight miles northwest from Fenner Station, on the A. & P. R. R.

The veins, or ledges, bear north by east, and can be traced on the surface for several miles. The principal vein is a contact, the west wall being described as porphyry, and the west quartzite, or granite.

The ore contains gold 760 fine, stained also with copper, and gives indications of silver, aside from that occurring alloyed with the gold. There were eleven locations made on the principal vein at the time of the visit of

my informant, Mr. E. Wolleb of San Francisco, who examined the district in February, 1886. The Arrow and the Red Cloud are the principal veins. But little work had been done. Water from the Arrow springs could be used for mining and milling purposes. but the excessive dryness of the locality it is feared will form a serious impediment to the working of the mines.

MOUNT ST. HELENA.

On the twenty-third of August, 1885, I started from the toll house to ascend Mount St. Helena. This station is about two thousand one hundred and thirty-seven feet above Calistoga, or about two thousand four hundred and sixty-eight feet above the sea level. There is no wagon-road, but a good trail, leading by a circuitous route up the sloping side of the mountain. The distance from the toll house to the summit is about four miles. The first bench has an approximate altitude of one thousand five hundred and seventy-five feet above the toll house, or three thousand nine hundred and ninety-three feet above the sea level. From this point, the mountain top may be seen at the distance of a mile or so. The ascent from this bench is not difficult.

Before reaching the foot of the highest peak, a depression may be seen to the left, through which a view of the valley beyond is obtained. On the right hand side of this ravine, there is a fine outcropping of basalt in distinct columns, which average about eighteen inches in diameter ; some, however, being three feet.

On the summit, the basalt occurs—the columns being broken off square and forming the extreme top of the mountain. This rock is peculiar and very interesting. It is somewhat brecciated or spotted, light colored, yellowish in places, in others a pale, undecided green; the latter seems to have changed from olivine. On the weathered surfaces, the iron has become peroxidized, and a reddish or tawny color is the result. There seems no doubt that the character of the rock has changed, and that it is now decidedly metamorphic. Under the microscope, the crystals imbedded in the magma forming the rock, are not distinct and have lost their luster. It is much to be regretted that it has been impossible to give this rock the careful study and thorough chemical and optical examination it deserves.

The sides of the mountain near the summit are covered with a greenish colored sand, resulting from the disintegration of the basalt. Lower down, near the toll house, the lava rocks, probably basalt, are dark brown, and inclose nodules resembling stone axes. If one of these only had been found, it would not be difficult to believe that it was made by human hands. One had a groove, very roughly cut, which the finder claimed had been made by human beings previous to the flow of the lava. Before I visited the locality, having seen this one only, I was inclined to the same opinion; but finding several resembling it on the same ground, I concluded that the grooving was the work of very recent hands.

On the summit of the mountain there are two brick columns that supported scientific instruments used by the Coast Survey, which had a station there for several months. There is also a bar of copper, marking the junction of Lake, Napa, and Sonoma Counties. The summit is nearly bare of vegetation, and is covered with broken blocks of basalt.

The elevation of Mount St. Helena, as determined by the Coast Survey, is four thousand three hundred and forty-three feet; Calistoga is three hundred and thirty-one, the Toll House about two thousand four hundred and sixty-eight, and the first bench three thousand nine hundred and

VIEW OF THE SUMMIT OF MOUNT ST HELENA FROM FIRST BENCH ABOVE TOLL HOUSE.

BASALTIC COLUMNS NEAR SUMMIT OF MOUNT ST. HELENA.

ninety-three feet. From the top of the mountain the view is very fine; on a clear day even grand. If a good grade should be made from the toll house, an easy matter, the locality would soon become a favorite place of resort.

There is reason to believe that St. Helena was once an active volcano, although the summit does not now present a crater-like appearance. That the action has not yet ceased is evinced by the hot springs at Calistoga and elsewhere, the emanations of carbonic acid in Clear Lake, especially at the remarkable spring at Soda Bay, the sulphur bank and quicksilver mines, and the ammoniacal springs near by.

June 12, 1841, this mountain was ascended by Wosnessensky, a Russian naturalist, sent out by the Academy of Science of St. Petersburg. He placed an engraved copper plate on the summit, which was removed by some vandal who found it there. It came into the possession of Dr. J. A. Veatch, who presented it to the California State Geological Survey. It would be interesting to know where it is now.

About Clear Lake there are great quantities of obsidian, from which the Indians for many years have not only made arrow and spear points, but have exported the material, or the manufactured articles, to distant tribes.

After thinking the matter over since my visit to this very interesting locality, and knowing of the evidences of recent volcanic action (recent in a geological sense only), I see no reason why the mountain may not again break out into active eruption at any time. It is not an uncommon circumstance for volcanoes to remain dormant for centuries, and then, without any special preliminary symptoms, to break out into violent eruption. Our frequent earthquakes are another evidence that the stupendous piles of eruptive matter, the result of volcanic action in centuries past, were thrown out by subterranean forces not yet extinct. Ætna remained dormant for several hundred years at a time; once, within historical period, for four hundred years; another interval was three hundred and fifty years. Vesuvius had been inactive for ages, when it suddenly burst into flames in the year 78 A. D., at which time the cities of Pompeii and Herculaneum were destroyed. It now rises only two thousand three hundred feet above the sea level; but in 1868, when augmented by the piling up of eruptive matter, its summit reached the height of four thousand two hundred and fifty-three feet—nearly that of St. Helena at present.

I would advise tourists in California to visit the hot springs of Calistoga, Clear Lake, and the summit of Mount St. Helena.

SAN DIEGO COUNTY.

Having found it convenient to visit the western part of San Diego County I am enabled to give some general information concerning it. It was my intention to commence at the Mexican line, and to have made a geological and mineralogical reconnoissance of the whole State to the northern boundary, but I was not able to carry out my plans. On several occasions during the last six years I have examined the eastern portion of this very interesting and important county, the results of which may be found in preceding reports.

I left San Francisco, May eighth, by steamer. The weather at this time of year is delightful on the coast, and a coasting voyage is always one of pleasure and interest. Passed Monterey at 4 P. M., and Point Sur, an outlying promontory, and arrived at Port Harford, San Luis Obisbo County, May ninth, at 2 A. M. Left this port at 7 A. M. and ran down by Point Sal and Conception. At 2 o'clock passed Goleta, and saw petroleum spreading over the sea, rising from submarine springs. As the ship throws aside the water in her passage, a strong smell of coal oil is observed. I had often heard of this locality and the oil springs, but I did not realize the extent of surface covered, or the signification from an economic standpoint. The smell is not of asphaltum, but of light coal oil, which to the experienced sense is distinctly different. This locality should be studied, and wells sunk at Goleta, in the hope that the source of these springs may be tapped and the oil utilized. At 3 o'clock P. M. the ship arrived at Santa Barbara, where she remained long enough to allow the passengers to see the town. I noticed a yellow or buff colored sandstone, which is now used for building purposes. It has been fully described under the head of Rocks and Building Stones. It is not very durable, which is evidenced by the decay of the Mission buildings, which are partially built of it. May tenth arrived at San Diego. In entering the harbor a striking feature is observed. The sea is covered with kelp, which, growing from the rocks beneath, spreads its flat leaves on the surface, and in time of storms is said to act like oil on the troubled waters, and to prevent the waves breaking as violently as they would otherwise do.

AREA OF SAN DIEGO COUNTY.

Assuming Bancroft's map of California, dated 1882, to be correct, San Diego County has an area of fourteen thousand four hundred and twenty-eight square miles, equal to nine million two hundred and thirty-three thousand nine hundred and twenty acres. There are eight States of the American Union that have less area than this one California county, as follows:

Rhode Island, square miles	1,306
Delaware, square miles	2,120
Connecticut, square miles	4,750
Massachusetts, square miles	7,800
New Jersey, square miles	8,320
New Hampshire, square miles	9,280
Vermont, square miles	10,212
Maryland, square miles	11,124

For seventy-five miles inland from the seacoast, the country is broken into irregular spurs and short mountain chains. The Colorado Desert

extends for about one hundred miles beyond this point to the Colorado River. The dividing ridge seems to be the San Jacinto Mountains, the highest elevation of which is eleven thousand feet. A portion of the Colorado Desert is below the sea level. The lowest depression, two hundred and sixty-two feet, is on section twelve, township ten south, and range twelve east, S. B. M., or very near that locality. The mud volcanoes lie in the northern part of section fifteen, township eleven south, and range thirteen east. This very interesting locality is fully described on folio 227 of the second annual report of the State Mineralogist, and a map of the region is also published in that volume. Beyond the basin of the dry lake the surface rises again, and is broken into isolated buttes which, from the almost total absence of water, have not been prospected, but appearances lead to the hope and expectation that valuable minerals will be found in them.

Since the discovery of carboniferous fossils, it is not unreasonable to expect, or at least to hope, that beds of true coal will eventually be found. A large bed of coal crops out on the seashore fifteen miles or thereabout, north of San Diego. At Elsinore also a bed of coal or lignite has been discovered on section twenty-six, township five south, and range five west, S. B. M., but no systematic exploration has been made. An approximate analysis of the latter will be found under the head of lignite. Salt is known to be very abundant, and since my last report extensive works have been undertaken along the shore of the ancient lake. I am informed by those interested that the enterprise is so far a success. My examination of the desert in 1881 led me to hope that nitrate of soda would be found. Other salts, in beautiful crystals, observed in the mud at that time should be examined by a competent chemist in the interest of the State. The so called desert lands are known to be very fertile, wanting water only to change them into a paradise. The climate is tropical, but exceedingly dry; rain seldom falls. The mountain divide separates two very distinct climates. To the east the country is hilly, and to a rather limited extent is traversed by streams of pure water. The hills are green and covered but rather sparsely with timber. The valleys are very fertile and well adapted for settlement, and the rainfall is sufficient to insure a crop nearly every year. This portion of the county has an approximate area of six thousand and eighty-four square miles, or three million eight hundred and ninety-three thousand seven hundred and sixty acres—a surface larger than the State of Connecticut.

Along the seacoast the climate is delightful. This portion of the county will undoubtedly support a large population. San Diego harbor is second only to that of San Francisco. The city is destined to become a great commercial center at no very distant day. The western slope of the divide is gradual, while that to the east is abrupt. This is the general character of all the mountain chains in California. The prospect of this county becoming a prolific gold-producing locality increases with the developments that have been made. Mines known to be productive have been discovered in the county in the Julian, Pinacate, and Carga Muchacho Mining Districts, while a vast area of unprospected country remains to be looked after.

The Carga Muchacho Mines, from discovery to June 17, 1882, worked fourteen thousand tons, which yielded $167,000, since which time the district has been idle. The mines lie in sections nineteen, twenty, twenty-nine, thirty, and thirty-two, in township fifteen south, range twenty-one east. Pinacate District is in the northwest corner of township five south,

range three west. The locality of Julian District will be given elsev
Besides gold and silver, the following minerals have recently been 1
in San Diego County: asbestus, clay, gypsum, mica, ocher, ortho
pegmatite, quartz. There are no doubt may others which will event
be found and utilized.

The stage road from San Diego to Julian Mining District, sixty
more or less distant, crosses a fertile and beautiful country. It p
through a succession of fine valleys—Cajon, Nuevo, Ballena, and S
Ysabel. The ascent is so gradual that the stage is able to make th
tance without difficulty in one day.

The following are roughly approximate altitudes taken with a
aneroid barometer, but by a single reading only:

Halfway House	180
Ridge near Cajon	510
El Cajon Valley	220
Rim of Cajon Valley, east	375
Fosters	260
Foot of Atkinson's grade	410
First bench	720
Head of grade	1,220
Summit	1,215
Nuevo	1,200
Foot of Hunsacker grade, four miles from Nuevo	1,760
Top of grade	2,230
Ballena Valley	2,240
Santa Ysabel Valley	2,700
Top of Coleman's grade, five miles from Julian	3,400
Julian City	4,000
Banner	2,800

For the first ten miles from San Diego heavy banks of drift, co
gravel and bowlders are met with. Then a large outcrop of co
granite may be seen, which presents a singular appearance, from spot
blotches of a darker color.

Santa Ysabel Valley is circular. It contains much good land. At
time of my visit it was covered with a luxuriant growth of wild
The rocks from this point to Julian seem to be syenitic. On Hunsack
Grade there is a large outcrop of orthoclase and pegmatite, of a qua
suited for the manufacture of fine pottery. At the town of Julian, 1
the Owens mine, coarse granite with mica crystals crops out. The cou
about Julian is generally mica schist, and of a quality bearing a stril
resemblance to that about Dahlonega, in Georgia. I was struck wi
marked likeness in other respects between the two districts.

JULIAN MINING DISTRICT.

This district, formerly called also Cuyamaca Mining District, was
covered and located in November, 1869, by Mike Julian, Webb Jul
James A. Bailey, and D. D. Bailey. These men had been prospectin
Arizona and Montana with indifferent success. In December placer m
were found, and worked in a small way. The first quartz mine discov
was the Van Wirt; the next the George Washington. Both were loc
on the same day, February 22, 1870.

The first Julian District, organized February 15, 1870, was bounde
follows, taken from the Recorder's books:

**Beginning one thousand yards west of Harrold's Store and running north five 1
and south five miles, and four miles west in width.**

M. S. JULIAN, District Record

several other mining districts. The following com-

The following is a statement by the Recorder of mines located up to August 30, 1870:

CERTIFICATE OF MINING LOCATIONS.

STATE OF CALIFORNIA, }
County of San Diego. } ss.

I, M. S. Julian, Mining Recorder in and for Julian District, in the said County and State, do certify that the record books of the said district in my possession show that the following claims were taken up in pursuance of the laws and resolutions of the said camp, and that the names of the claimants are as given below, and that the quantity claimed and the date of the claim are as hereinafter given—that is to say:

George Washington—1400 ft.; February 22, 1870; H. C. Bickers, etc.
Otilia—2,000 ft.; February 26, 1870; Mark Garrett, etc.
Wall Rock—2,400 ft.; February 20, 1870; John Fetherstone, etc.
Hammell—1,200 ft.; February 22, 1870; Wm. H. Hammell, etc.
Ida—1,200 ft.; February 22, 1870; Levi Hammell, etc.
Van Wirt—1,200 ft.; February 22, 1870; Calaway Putman, etc.
War Path—2,000 ft.; March 14, 1870; A. B. Woods, etc.
Hayden—1,000 ft; March 4, 1870; Paul Hayden, etc.
Good Hope—1,800 ft.; March 7, 1870; Geo. W. Swain, etc.
Lincoln—950 ft.; March 9, 1870; H. D. Young, etc.
Owens—1,000 ft.; March 11, 1870; James Kelly, J. E. Pember, Barney Owens, Francis Murphy.
High Peak—1,400 ft.; March 4, 1870; S. Southerimer, etc.
Washoe—2,200 ft.; March 6, 1870; Felix Fitzpatrick, etc.
Ione—2,000 ft.; March 2, 1870; D. D. Bailey, etc.
Aguadiente—2,000 ft.; March 21, 1870; H. E. Bingham, etc.
Monroe—2,400 ft.; March 24, 1870; Charles F. Monroe, etc.
Andy Johnson—1,200 ft.; March 22, 1870; John Bush, etc.
San Diego, No. 1—2,200 ft.; March 2, 1870; John P. Chambers, etc.
Keystone—1,200 ft.; April 2, 1870; J. M. Broom, etc.
Bedrock—1,200 ft.; April 2, 1870; John W. Pace, etc.
True Hope—1,400 ft.; June 6, 1870; J. B. Wells, etc.
Gilman—1,600 ft.; April 13, 1870; L. S. Gilman, etc.
Monitor—1,800 ft.; April 4, 1870; S. W. Black, etc.
Eagle—1,600 ft.; April 5, 1870; Wm. J. Moran, etc.
Leslie—1,400 ft.; April 6, 1870; Robert Leslie, etc.
Fairview—1,000 ft.; February 22, 1870; F. Scarborough, etc.
Crown—1,000 ft.; March 16, 1870; Frank Able, etc.
Horseshoe—800 ft.; April 4, 1870; C. R. Philips, etc.
Lone Star—1,200 ft.; February 28, 1870; J. Parsons, etc.
Rough and Ready—1,200 ft.; May 17, 1870; M. Martin, etc.
Challenge—2,000 ft.; May 10, 1870; O. P. Powers, etc.
Fair Play—1,600 ft.; May 26, 1870; R. J. Carroll, etc.
Swain—1,200 ft.; June 8, 1870; W. H. Swain, etc.
Pioneer Mill—1,400 ft.; May 1, 1870; James McMechan, etc.
I. X. L.—1,400 ft.; May 27, 1870; William Estes, etc.
Owens, First Extension—1,000 ft.; June 15, 1870; G. V. King, etc.
Crown Prince—600 ft.; April 2, 1870; R. Shelton, etc.
Crown, First Extension—800 ft.; June 29, 1870; D. Lipman, etc.
Home Stake—1,000 ft.; April 12, 1870; Joseph Moss, etc.
Farley—1,000 ft.; March 28, 1870; Richard M. Farley, etc.
Hudson—600 ft.; June 14, 1870; E. C. Phelps, etc.
Golden Rule—1,200 ft.; June 21, 1870; A. Pauly, etc.
North America—1,000 ft.; July 5, 1870; E. A. Ary, etc.
Sullivan—1,000 ft.; June 28, 1870; D. O. Sullivan, etc.
Victoria—1,000 ft.; July 11, 1870; M. Jones, etc.
San Francisco—1,200 ft.; March 21, 1870; J. P. Wealand, etc.
Minnesota—1,000 ft.; July 18, 1870; S. A. Coolidge, etc.
Little Giant—2,000 ft.; April 12, 1870; A. P. Dodge, etc.
Shamrock—1,000 ft.; April 23, 1870; John Madin, etc.
O'Connor and Ryan—2,200 ft.; April 4, 1870: David O'Connor, John Ryan, etc.
Owens' Ext. East—400 ft.; April 13, 1870; George McNier, etc.
Sonoma—1,800 ft.; March 28, 1870; B. T. Williams, etc.
Roanoke—1,400 ft.; March 28, 1870; Eli McDaniels, etc.
Hayden, First E. Ext.—1,200 ft.; April 11, 1870; Eugene Kelly, etc.

And I further certify, that the said claims are within the said Julian District, in the said county and State. In witness whereof I have hereunto set my hand and affixed my private seal, there being no public seal for said district, this third day of August, A. D., 1870.

[SEAL.] M. S. JULIAN, Recorder.

The Present Julian District, called JULIAN MINING DISTRICT, consolidates *Julian*, *Banner*, and several other mining districts. The following com-

mittee reported March 27, 1881: D. D. Bailey, Robert Gardner, George V. King, Committee.

The district is bounded as follows: commencing at the northeast corner of section four, township twelve south, and range four east, San Bernardino meridian, and running three miles west, to the northwest corner of section six; thence south three miles, to the southwest corner of section eighteen; thence east one mile, to the southeast corner of section eighteen; thence southwest along the line of the Santa Ysabel grant, to the southeast corner of said grant; thence along the line of said grant, in a westerly direction, four miles; thence in a direct line to the northwest corner of the Cuyamaca grant; thence along the north boundary of said grant, to the northeast corner; thence along the line of said grant, five miles; thence east five miles; thence north to the southwest corner of San Felipe grant; thence along the westerly line of said grant, to the place of beginning.

MINING LAWS OF JULIAN DISTRICT IN 1870.

At a meeting of the miners of Julian Mining District, held April 27, 1870, in pursuance of a notice given, by posting same in three public places, five days previous to said meeting, M. S. Julian acted as Chairman, and L. B. Hopkins, Secretary. The meeting being called to order, the committees appointed to revise and amend the mining laws of the district, reported the following:

Substitute for Article IV of the present laws, and the following additional laws:

Art. IV. All locations shall be recorded within ten days from the date of location, and shall have at least one day's work done on the claim prior to recording, and shall have at least one day's work done for each name on the notice or record within thirty days from date of record; and two days' work for each name so recorded done within sixty days from date of record; shall hold the claim and ledge free from relocation for one year from date of record, provided, said work be measured and recorded by the District Recorder.

Art. VI. All persons locating claims in this district shall erect a stake or monument on a prominent point on his claim, at least two feet high, upon which he shall place a notice defining the extent and boundaries of his claim, with the name of the ledge, and each owner in the same, and keep the same up permanently; and the same rule shall apply to all claims now located; and, further, that all claims that shall fail to have a stake, monument, or notice for the space of fifteen days consecutively, shall be subject to forfeiture, unless the party owning shall be able to prove sickness or other inability to comply with said law.

Art. VII. These laws can be altered or amended by a general meeting of the miners, called by a notice posted in three public places in the city, naming time, place, and object of the meeting, and signed by ten miners of the district.

Art. VIII. These laws shall take effect and be enforced from and after their passage.

On motion, the above report and laws were received and adopted for the future government of the district.

M. S. JULIAN, Recorder and Chairman.
April 27, 1870. L. B. HOPKINS, Secretary.

Julian City, once a thriving town, was at the time of my visit somewhat dilapidated; some of the houses were empty, but a new brick building had just been erected, a ten-stamp quartz mill was being built at the Owens Mine at the edge of the town, and other signs of renewed prosperity were manifested. The town is nearly at the summit of the Santa Ysabel Mountains. On a clear day, Point Loma at San Diego, and the Coronado Islands may be plainly seen. From the Oriflamme Mine, a short distance east, the desert, sloping away to the east, is in full sight. The principal street in Julian bears N. 63° west, magnetic.

In 1871 the town had a population of five hundred, and there were one hundred occupied houses. In 1873 the excitement which followed the discovery of the district began to subside. The cause was said to be prejudice against the lower country, and threatened litigation as to the boundaries of the Cuyamaca grant. This was eventually decided in favor of the miners.

In 1870 there were two quartz mills, of fifteen stamps Washoe pattern, at work. The gold was richer on the surface. Placer mines were worked in the low hills of the Santa Ysabel Valley, but they did not pay very well.

Bullion began to be shipped from Julian in April, 1871. Up to the middle of September $10,341 had been sent forward by Wells, Fargo & Co., and $5,580 by others. The gold was worth $18 per ounce. The following table, from the report of Rosseter W. Raymond for 1870, will give a good idea of the character of the district at that time:

MILLING RESULTS OF LOTS OF ORE FROM VARIOUS MINES IN JULIAN DISTRICT.

Name of Mine.	Tons Crushed.	Value per Ton.	Value of Crushing.
Lone Star	5	$70 00	$350 00
Owens	16	51 00	816 00
High Peak	10	42 00	420 00
Hayden	19	40 00	760 00
Pride of the West	1½	31 00	46 50
San Diego	19	15 00	285 00
Forty-nine	12	12 50	150 00
Lone Star	7	7 00	49 00
Keystone	4	7 00	28 00
San Diego	51	6 00	306 00
Sherman	4	4 82	19 28
North Star	6	4 50	27 00
North America	6	4 00	24 00
Monitor	6	4 00	24 00
Shamrock	7	3 50	24 50
Hannon	3	3 50	10 50
Eagle	10	2 90	29 00
Eagle	5	2 75	13 75
Ella	3	1 25	3 75
White Fawn	3	0 37	1 11
	197½		$3,387 39
Average per ton			$17 15

At the time the prosperity of this mining district was at its heighth, the San Diego *Union* estimated yield of gold for 1871 at $175,919, and for 1872 at $488,670.

After a careful examination of Julian Mining District, I am led to the following conclusions:

The quartz veins are generally rather narrow but remarkably rich. First and last there has been an important output of bullion from the district. I have not had time to arrange statistics obtained, in shape to be of much service. Wood and water are scarce; none of the mines have yet been opened or explored sufficiently to prove their capacity to yield gold. Considering the present condition of things in California, these mines can be worked to greater advantage than when first opened. Milling near Julian City cannot be conducted without very considerable difficulty, owing to the altitude, and consequent scarcity of fuel and water, but at Banner, six miles distant by graded road and twelve hundred feet lower in altitude, there is a beautiful valley through which a considerable stream of water—the San Felipe River—flows, affording sufficient water-power to drive several small mills or one large one, during the year; the water is more abundant during the winter months.

If first class reduction works should be placed at Banner, with ample capital, and all the ores from the district be worked in them, an era of

prosperity would probably be the result which would exceed any before experienced in this district, employment would be given to many miners and tributors to the advantage of the district, the county, and State. The locality is a delightful one, and a desirable place for residence, which is not always the case where gold mines are found.

Julian City lies in sections five and six, township thirteen south, range four east, S. B. M.

BANNER DISTRICT

Is situated on sections two and three, township thirteen south, and range four east, and joins Julian on the east. It was discovered in August, 1870, by a party of men from Julian who were looking for wild grapes. A mine afterwards called the Redman was discovered on a sloping mountain side in San Felipe Cañon. BANNER DISTRICT was soon afterward organized. The district now incorporated with Julian has many advantages, the most important being the presence of water in abundance for milling and sufficient for limited water power, limited to season only, for in the winter and spring, I was informed, it is ample for any future requirements of the district. As mentioned before, Banner is twelve hundred feet lower than Julian, from which it is distant three and a half miles by trail and six miles by graded wagon road. To work the mines of the consolidated districts to the best advantage all the milling and concentration should be done by water power in San Felipe Cañon, and the ores from all the upper mines brought down by a tram road for reduction. By this plan all the present difficulties would be overcome. From appearances, ores could be supplied to such general reduction works for many years to come. There is more silver and less gold in the bullion produced in Banner than that taken from the Julian veins. In 1870, when many mines were being worked in both districts, bullion from Julian sold at the stores for $16 per ounce, while Banner bars brought only $12 to $14. The following table shows the condition of the principal mines in Banner during the early mining excitement. The information is compiled from various publications and reports:

NAME OF MINE.	Average Yield.	Width of Vein.	When Discovered.	Remarks.
Golden Chariot.	Most productive in the district. 100 tons yielded $32,000; 50 tons, $8,100; 52 tons, $13,261.	2 to 4 feet.	February, 1871.	Contact vein, country slate and granite. In July, 1874, cleaned up $9,500 in 12 days, with 10 stamps.
Kentuck........	$40 per ton.	16 inches.	October, 1870.	Shaft 80 feet deep.
Madden	$75 per ton.	At 80 feet, 14 inches.	September 10, 1870.	
Ready Relief....	10 tons yielded $980.	From 2 to 8 feet.	August, 1870.	Tunnel 130 feet, claim 1,000 feet in length.
Redman........		6 to 10 feet.	August, 1870.	First mine discovered in the district. Shaft 80 feet deep, and tunnel connecting.

At the time of my visit only one mill was running on the ores of the Ready Relief or Bailey Brothers' Mine. Some other mines were being prospected in a small way, but with what success I was not able to learn. In 1874 there were seventy-five stamps running in Julian and Banner.

When I was at Julian City there was no mill running, but at the Owens Mine, almost in the Town of Julian, a new and good ten-stamp mill was being built. The vein in this mine is small, but the quartz is rich in gold. A pile of ore has been accumulated which contained several hundred tons, and looked and prospected well; from which it is fair to predict that enough gold will be taken out to pay for the mill and leave a surplus. While the new mill is running the mine will be well prospected, and there is reason to hope and expect that considerable bodies of ore will be found. There is no special or well defined croppings to be seen on the surface. The old workings have fallen in. There is a shaft down one hundred and eighty feet in depth, well timbered, through which the ores are hoisted. The mine lies three hundred feet above the town, and very near the summit of the ridge. To the left is a gap through which the road to Banner runs. On a hill near the town, and to the left of the road, may be seen some old workings in which there are some splendid quartz croppings, but in small detached fragments, in a schistose formation dipping at a steep angle. I was struck with the resemblance of this formation to that in Findley Ridge, at Dahlonega, in Georgia, and was led to the inquiry if it would not pay to pipe it down as they do there. A full description of the methods employed in Georgia may be found in the fifth annual report of this office, folio 142.

The Owens Mine was located March 11, 1870. The old workings were quite extensive. There was a shaft two hundred and seventy-five feet, from which levels ran east and west. The first level, one hundred feet below the surface, ran east two hundred feet and west one hundred feet. The second level, two hundred feet deep, ran two hundred feet east and one hundred and eighty feet west. Third level, at bottom of shaft, ran east two hundred and sixty feet and west two hundred feet. In eight months, ending June, 1873, gold to the value of $42,319 50, was taken from nine hundred and twenty tons of quartz. The company was incorporated with a capital stock of $500,000. In 1873 there were fine hoisting works at the mouth of the shaft—now removed.

READY RELIEF MINE, BANNER.

The Ready Relief Mine, the only one now being profitably worked in old Banner District, was discovered in August, 1870, immediately after the Redman, of which it is an extension. It is generally known as the Bailey Brothers' Mine. The southerly extensions of the Ready Relief Mine are the Hubbard and the South Hubbard. The claim is one thousand by two hundred feet. The ledge is from eighteen inches to eight feet in width. The vein is interstratified with the clay slate formation. The slaty cleavage of the country rock is undoubtedly due to lateral pressure, which has also distorted and plicated the vein so that it is found in folds, which are technically called "rolls." I am inclined to the opinion that the vein was formed by solfataric action in a plastic mud before the mountains were elevated, and that the vein has become plicated by its own weight while still in a soft condition. After visiting the mud volcanoes in this county—and not many miles distant—now in action, it is not difficult to conceive such an idea. These mud volcanoes are described in the second annual

report of this office, folio 227, to which the reader is referred. The plications of the vein are unlike anything I have ever seen or read of.

The engraving conveys a good idea of one of these folds as seen at the end of the upper tunnel. The slates are highly aluminous. In the tunnels the sides are soon coated with an incrustation of alum.

The ore in the Ready Relief Mine is blue ribbon quartz, much resembling that of the Sheep Ranch Mine in Calaveras County. The gold is free. The sulphurets are concentrated and saved, but I have no information as to their value. Some of the clay slate contains gold; it resembles the ores of the Black Hills in Dakota, and those of the old Oso Mine in Mariposa County. These slates should be thoroughly prospected and cross-cuts made from both sides of the vein. It might be found that they would pay to crush in large water-power mills with economical management. The general direction of the vein is south southeast. The dip is at almost any angle, owing to the folds before mentioned.

In 1874, the mine was opened by three tunnels, one two hundred feet, the others one hundred and fifty feet each; at the end of the upper tunnel there was a shaft to the surface, one hundred and ten feet above. The mine at present is worked by an upper tunnel of five hundred feet, and a

shorter one sixty feet below, through which ores are conveyed to the mill. Owing to the uprise shaft, the ventilation in the mine is perfect.

The mill is in rather a dilapidated condition, but is still doing good work. It consists of two batteries of five stamps, and driven by steam. The stamps weigh about seven hundred pounds. Each battery is supplied with an automatic ore feeder. Below the aprons there are three Hendy's concentrators, which save a considerable quantity of sulphurets. The mill is only run ten hours per day, during which seven tons of ore are crushed. Wood costs $1 50 per cord for cutting, and $2 for hauling to the mill. The mill is forty feet below the lower tunnel, from which the ores are carried in chutes. The dump of the mine, in which the rejected vein matter is piled, contains some good ores, and I am of the opinion that it would all pay in a large, economical mill. A great deal of low grade ore could be obtained from the hill alongside of the vein. An inexpensive experiment would reveal the value of this ore, and decide if it could be made to pay or otherwise.

In 1876 one hundred tons of ore yielded $30 per ton. The present average yield is not stated, but is admitted to be satisfactory. It is claimed that the output to the present time exceeds $350,000. The gold is worth $14 50 per ounce.

Mr. Charles J. Sauer thinks the water in the south fork of San Felipe River runs twelve miners' inches in summer, and much more in winter. I visited, with Mr. Bailey, a spring which gushes from the hillside at an elevation of five hundred feet above the mill. At the time of my visit, in May, the quantity flowing was at least thirty inches, and Mr. Bailey informed me that the flow was nearly the same all the year round. With the great altitude, this water would afford power sufficient to run extensive reduction works.

The Oriflamme Mine is situated in what was formerly the Desert Mining District, now incorporated in Julian. It belongs to a Boston Company, "*The San Diego Development Company.*" Their ten-stamp mill has recently made a run which Mr. Henry M. Dow, the Superintendent, informed me yielded from $4 to $10 per ton. Water and wood are scarce, and mining and milling are conducted under difficulties. From this mine the Great Colorado Desert may be seen for many miles to the eastward. The sight is a very grand and interesting one.

The Stonewall Mine, formerly the *Stonewall Jackson*, is situated in the northern part of the Cuyamaca Grant about seven miles distant from Julian District in a direct line. By road it is considerably further. If the United States section lines were run out, it would lie in section four, township fourteen south, and range four east. It is not in the Julian District, as may be seen by referring to the map published with this. It has the reputation of being the largest vein in the mining region about Julian City. I regret that for want of time I could not visit this mine.

In 1870 the Stonewall was reported to be twenty feet wide. Dr. J. E. Fulton, one of the present owners, informed me that the width varied from six to forty feet. The country rock is said to be like that of Julian District—a mica schist with coarse granite. The ores are now being crushed in a steam-driven mill of ten stamps. I am informed that the mine has produced in nine months $85,000. The last clean-up yielded $40 per ton. The United States Mint has bought gold from this mine for $18 per ounce. The mine is opened by a vertical shaft one hundred and fifty-five feet deep, from which levels are driven. The lay of the country is such that there is no way to drain the mine by adit. Water for milling and for the steam

boiler is brought in iron pipes a mile or more, from the mountains. In 1871 the mine had a shaft one hundred feet deep, and a level at sixty feet running one hundred and eighty feet to the north and one hundred feet to the south. Stoping had not then commenced.

This promising mine has always been worked under difficulties. In 1871, the small mill then in operation could only run five hours each day for want of water. At that time the mine is said to have yielded from $12 to $20 per ton. During my stay in San Diego County I heard the mine invariably well spoken of.

CALIFORNIA MINERALS.

Mineral species known at the present time to exist in the State of California, carefully revised and corrected and brought up to date, intended to be a check list and foundation for future work. All technical or scientific descriptions have been omitted except in case of minerals not mentioned in former reports, or where some special work has been done, or some interesting feature discovered or noticed. The list has been arranged alphabetically for convenience of reference.

1. AGALMATOLITE. Minerals resembling agalmatolite occur in San Luis Obispo County, and at Greenwood, El Dorado County, the latter in a vein or stratum from six inches to a foot in thickness.

AGATE—See Quartz.

ALABASTER—See Gypsum.

2. ALBITE. Soda feldspar, a specimen in which quartz crystals are imbedded, was found in the San Lucas Mine, Inyo County. It is now in the private cabinet of Dr. Gould at San Diego. Dana gives as a locality the vicinity of the Murchie Mine in Nevada County, with gold and pyrite. The abundance of soda in the desert soils in California would indicate albite in the crystalline rocks.

3. ALTAITE. Telluride of lead, said to exist in Rawhide Ranch Gold Mine, Tuolumne County; in the Frenchwood Mine, Robinson's Ferry, Calaveras County, with petzete, calaverite, and other tellurium minerals; also in the Morgan Mine, Carson Hill, Calaveras County, in large masses, with free gold; at the Adelaide Mine and the Golden Rule Mine, in Tuolumne County, and elsewhere in the State.

4. ALUM. Occurs in mineral waters; as an incrustation, ten miles north of Santa Rosa, Sonoma County; near Newhall, Los Angeles County; near Auburn, Placer County; in thick incrustations at the Sulphur Bank Quicksilver Mines, Lake County; said to occur at Silver Mountain, Alpine County; at Howell's Mountain, Napa County; at the mud volcanoes, San Diego County, and at numerous locations, as an incrustation on rocks; I have noticed it on the bedrock laid bare by hydraulic streams, near Dutch Flat, Placer County, in a crystalline state.

AMIANTHUS—see Amphibole.

5. AMPHIBOLE. Actinolite, anthophyllite, amianthus, asbestus, hornblende, mountain cork, mountain leather, tremolite, etc.

ACTINOLITE. Abundant in counties bordering on the Bay of San Francisco; found in bowlders, or rolled masses, in Alameda and Contra Costa Counties, which show, when broken, beautiful green radiating crystals; found in rocks of the Coast Range; near Knight's Ferry, Stanislaus County; at Petaluma, Sonoma County, with garnets; on the Mariposa estate, Mariposa County, in fine needle crystals; in Quartz Eagle Gulch, Plumas County; twelve miles from Gilroy, Santa Clara County; Eureka, Humboldt County; Santa Rosa, Sonoma County; Reed's Ranch, Marin County; and in the Lone Mountain Cemetery, San Francisco.

ANTHOPHYLLITE has been found in Slate Range, San Bernardino County.

ASBESTUS—

Butte County. Eighteen miles south of Oroville.

Calaveras County. Salt Spring Valley and Jenny Lind Hill.

Del Norte County. Exact locality not stated.

Fresno County. French Gulch, Potter Ridge Mining District, near Fresno Flat; Fine Gold Gulch.

Inyo County. Numerous localities in the Inyo Mountains.

Los Angeles County. Near Newhall.

Mariposa County. Mount Bullion and Bear Valley.

Placer County. Swiss Boy and Leed's claims, one mile below Rice's bridge.

San Diego County. Seven miles east of Elsinore, section six, township five south, range three west, S. B. M. This deposit is now being worked and boiler covering, etc., manufactured at Elsinore.

Shasta County. Exact locality unknown.

Tulare County. White River.

Yolo County. California Mine.

HORNBLENDE—

Calaveras County. At Vallecito.

Contra Costa County. At San Pablo.

Monterey County. At Soledad.

Sacramento County. At Folsom.

Sonoma County. At Healdsburgh, and as a constituent of rocks in numerous localities in the State.

MOUNTAIN CORK has been found in Butte County, at Red Hill, and in Tuolumne County.

MOUNTAIN LEATHER. Amador County, in Little Grass Valley Mine, Pine Grove District, and in Mariposa and Tuolumne Counties.

TREMOLITE. Found white and fibrous in limestone at Columbia, Tuolumne County, and in Santa Cruz Mountains, Santa Cruz County.

6. ANDALUSITE. Found in abundance in the slates in Fresno and Mariposa Counties. In the former county, on the Chowchilla River, near the road to Fort Miller, or Millerton. In the latter, at Hornitas, at Moore's Hill, twelve miles south of Mariposa, and near the Ne Plus Ultra Mine.

ANDRADITE—see Garnet.

7. ANGLESITE. Sulphate of lead. This is rather a common mineral in southeastern California, and specially so in Inyo County. In the Cerro Gordo it has yielded a very considerable portion of the lead bullion sent from that locality. It occurs with bindheimite and linarite and galena, at the Modoc Mine, and with geocronite and argentiferous galena and sinerite at the Santa Maria Mine, and the Eclipse Mine in the same county.

8. ANHYDRITE. Anhydrous sulphate of lime, found near Anaheim, in Los Angeles County, and in pale blue fibrous specimens in the Inyo Mountains, near Lone Pine; lately found in considerable quantity in the gypsum beds in Santa Barbara County—gray, very dense and heavy, compact to granular; shows signs of sedimentary origin.

ANHYDROUS SULPHATE OF SODA—see Thenardite.

ANTHRACITE—see Mineral Coal.

ANTIMONY—see Cervantite and Stibnite.

ANTIMONY OCHRE—see Cervantite.

ANTIMONY SULPHIDE—see Stibnite.

9. APATITE. Phosphate of lime. According to the report of the San Jacinto Tin Mining Company of San Bernardino County, this mineral, rare in California, has been found near the company's property in San Bernardino County. No special description is given of the mineral or its occurrence.

10. ARAGONITE. Carbonate of lime, found in beautiful transparent crystals in Colusa County in the Candace Copper Mine; New Almaden Quicksilver Mine, Santa Clara County; Inyo County, Cerro Gordo Mines; Colusa County, ranch of J. M. Pugh, near Smithville.

ONYX MARBLE, a variety of aragonite, is found also in numerous localities, as follows:

Kern County. Six miles from Kernville.

Los Angeles County. Santiago Cañon, twenty-five miles from Santa Ana, in a ledge twelve feet thick.

Placer County. At Gold Run.

San Luis Obispo County. On section nine, township thirty-two south, range fifteen east, and at several other localities.

Siskiyou County. Near Soda Springs Hotel, and near Yreka.

Solano County. Near Suisun; near Vacaville, and elsewhere in the county.

Tehama County. In township twenty-five north, and range seven west, in a vein four feet thick.

ARAGOTITE—see Petroleum.

ARENACEOUS LIMESTONE—see Calcite.

11. ARGENTITE. Silver glance, vitreous silver, sulphuret of silver, found in Inyo County, in the Minietta Belle Mine; in the Kearsarge Mountains, near Independence, in cubical cystals; in Deep Spring Valley, at a depth of sixty feet from surface.

In *Mono County*, eight miles south of Benton.

12. ARSENIC. Metallic arsenic has been found at the Alisal Mines, twenty-five miles from the Mission of San Carlos.

ARSENICAL PYRITES—see Arsenopyrite.

13. ARSENOLITE. Exchequer Mine, Alpine County, after enargite; at the Armagosa Mines, San Bernardino County, in large masses.

14. ARSENOPYRITE. Mispickel. This mineral is quite abundant in California, but generally in thin seams rich in gold. The following are localities where it is found in uncommon masses, or of superior quality:

Calaveras County. Eureka Mine, with gold.

El Dorado County. With gold, near Georgetown.

Inyo County. Several localities.

Nevada County. Betsey Mine, Grass Valley.

Placer County. Near Auburn, with tellurium and gold.

San Diego County. Rich in gold.

Sierra County. North fork claim, Forest City, rich in gold.

ASBESTUS—see Amphibole.

ASPHALTUM—see Petroleum.

15. ATACAMITE. Chloride of copper. Locally given in Dana's Mineralogy, Inyo County; this is doubtful. I am familiar with the county, and have never seen or heard of a specimen being found.

AVENTURINE—see Quartz.

16. AZURITE. Azure copper ore, chessy copper, blue malachite, mountain blue. It is quite common in the Inyo Mountains, from the White Mountain to Coso, with cerusite, bindhermite, anglisite, and linarite; in the Modoc Mine, in Inyo County, and with chalcopyrite and bornite at Copperopolis, Calaveras County.

17. BARITE. Barytes, cawk, heavy spar, terra ponderosa, etc. This mineral is known to exist in at least six counties in the State, as follows:

Alpine. Morning Star Mine.

Calaveras. Satellite Copper Mine.

Inyo. In White Mountain Range; in a vein in Alabama Range.

Nevada. With gold, Malakoff Hydraulic Mine, North Bloomfield.

Plumas. With lead and copper ores, north arm of Indian Valley; with tetrahedrite, Irby Holt Mine, Indian Valley.

San Bernardino. Milk white and honey yellow, Calico silver mines.

18. BERNARDINITE. Near Santa Monica, Los Angeles County, described by J. M. Stillman, in American Journal of Science and Art, third series, volume 18, folio 57. It has since been found near Santa Rosa, in Sonoma County.

19. BINDHEIMITE. Hydrous antimoniate of lead. This rare mineral has been found at the Union Mine, Cerro Gordo, Inyo County, and with anglesite at the Modoc Mine, in the same county. There is some doubt as to the identity of the specimens.

20. BIOTITE. Hexagonal mica. Grass Valley, Nevada County. A specimen was seen by Professor Blake in the cabinet of C. W. Smith, Grass Valley.

BISMUTH—see Bismutite.

21. BISMUTITE. Hydrous carbonate of bismuth, stream bismuth. Found at a single locality in the State, on Big Pine Creek, Inyo County, found in drift while sluicing for gold.

BITUMEN—see Asphalt, under head of Petroleum.

BLACK JACK—see Sphalerite.

BLACK SANDS—see Magnetite.

BLENDE—see Sphalerite.

BLOODSTONE—see Quartz.

BLUE MALACHITE—see Azurite.

BORACIC ACID—see Sassolite.

22. BORATE OF STRONTIA. Mentioned in a letter written by Dr. John A. Veatch to the California Borax Company, quoted in full in the third annual report, part 2, folio 15.

23. BORAX. Borax was first discovered in California in the waters of Tuscan Springs, in Tehama County, January 8, 1856. The water was brought to San Francisco by Dr. Trask, State Geologist, and the analysis made by L. Lanszweert. The crystals then obtained were sent to the museum of the California Academy of Science. Borax Lake was discovered by Dr. John A. Veatch, in September, 1856. This deposit was worked from 1864 to 1868, during which time it produced 1,181,365 pounds of borax. Borax fields were discovered in San Bernardino County, February 14, 1873. These deposits have been worked by the San Bernardino

Borax Mining Company, who have produced very large quantities of borax. This valuable mineral has since been found at a number of localities in the State: In Death Valley, Inyo County, 1873; at Desert Springs, called also Cane Springs, in Kern County, February 15, 1872, from whence a considerable quantity has been extracted. The dry lake in which the borates are found is situated in township thirty south, range thirty-eight east, Mt. Diablo base and meridian. Borax and the borates have been found in considerable quantities in San Bernardino County, near Calico, which deposit is at the present time being worked.

The reader is referred to former reports of this office, especially the third annual report, for information concerning this mineral and its production in the State.

24. BORNITE. Erubescite, horseflesh ore, purple copper ore, variegated copper ore, etc.

Calaveras County. At Copperopolis and Campo Seco.

Fresno County. With chalcopyrite and pyrite, at King's River.

Inyo County. Inyo Mountains.

Plumas County. Light's Cañon, Genesee Valley, and at the Siegel Mine.

Santa Clara County. Near Lexington.

Shasta County. At Copper City.

25. BRONZITE. For localities, see Enstatite.

BUHR STONE—see Quartz.

BUILDING STONES, there not being many species, they have been described under a special heading.

26. BROMINE. Said to occur with free iodine in the serpentine rocks, at Point Lobos, near San Francisco. Report on the geology of the coast mountains, etc., J. B. Trask, State Geologist, 1884, folios 26 and 92.

Bromine occurs as bromide of potassium in the waters of San Francisco Bay, and in the bitterns or concentrated mother liquors, from which bay salt crystallizes out in the proportion of 1.090 parts in 1000 as shown in analysis made in 1879, by Fr. Gutzkow, and quoted in the second annual report of this office, folio 223.

27. CALAVERITE. Telluride of gold and silver. This mineral occurs sparingly in the mines of Carson Hill, near Angel's, at the Morgan Mine with massive gold, at the Melones Mine, and at the Golden Rule Mine, Calaveras County.

28. CALCITE. Anthraconite, arenaceous limestone, carbonate of lime, calcareous spar, calc spar, dogtooth spar, Iceland spar, limestone, lithographic stone, marble, stalactite, stalagmite, travertine, tufa, thinolite, etc. This mineral is abundant in California, and occurs in many forms. It is found not only in extensive beds, but as distinct varieties, resulting from changes well known to mineralogists. It is a common mineral in veins of silver, lead, copper, zinc, and quicksilver, and sparingly in gold mines. It would be impossible and useless to enumerate all the localities in the State, but the following are given as the most important and best known:

Amador County. Black calcite, near Volcano.

Butte County. Blue limestone and anthraconite, at Pence's ranch.

Calaveras County. *Anthraconite*, near newly discovered caves at Murphys. The odor of this mineral is remarkable. Sitting one day in the hot sun, and breaking while studying the rock, I noticed with much

interest the penetrating and actually fetid smell that arose every time a blow of the hammer was made. I was annoyed at the same time by swarms of flies, but did not immediately connect their presence with the smell. After a time the idea occurred to me that they were attracted by the odor, which I immediately proved to be the case by the following experiment: Leaving my seat, I retired to a distance and awaited the dispersion of the flies. Returning, I laid some fragments on a larger piece and crushed them quickly with rapid blows. The flies immediately reappeared and settled in large numbers on the powdered rock. After a time, the smell having gone, the flies departed as before. This was repeated a number of times, and was witnessed with interest by the parties who were visiting the cave at the time.

El Dorado County. A large deposit of limestone at the Alabaster Cave and lime works, where it is very extensively burned for lime; near Mud Springs.

Inyo County. Thinolite found in considerable quantity near Owens' Lake, and on the Mohave Desert, in the beds of ancient lakes; and in Death Valley, at Cerro Gordo; fine crystals of dogtoothspar and blue calcite occur; at Darwin, Iceland spar, very transparent and fine; at Palma Mine, fine crystals; with gold and other ores at Modoc Mine.

Kern County. With malachite and melaconite, San Amedio Ranch. Lithographic stone on section twelve, township thirty-two south, range thirty-four east, Mount Diablo meridian.

Lassen County. Several localities.

Mariposa County.

Mono County. Thinolite, valley of Mono Lake, where it has been burned to an inferior quality of lime.

Placer County. Near Clipper Gap; extensively burned to lime at Cave Valley, five miles south of Auburn.

San Bernardino County. Near Colton, burned for lime by hydrocarbon furnace, in which California petroleum is used as fuel.

San Diego County. Thinolite, Colorado Desert.

San Francisco County. Peninsula near the city, dogtooth crystals in fissures of metamorphic rocks.

Santa Clara County. Hills back of Mayfield, burned for lime. Good specimens of Iceland spar are sometimes found; with quicksilver ores in the New Almaden, Guadalupe, and Chapman Mines.

Santa Cruz County. Near Felton and Santa Cruz, extensive beds of crystalline limestone occur, which is burned in a large way for lime.

Siskiyou County. Arenaceous limestone, found in Middleton's tunnel, under the bed of the Klamath River.

Santa Catalina Island. On the coast of Los Angeles County, pink calcite is found, with quartz, etc.

Tufa, or travertine, is found in several localities, but it has not been studied.

MARBLES occur in numerous localities in the State; some of them are of excellent quality, and a few are exceptionally fine.

Amador County. Near Ione, a red marble is found which resembles the Rosso Antico, so much prized in ancient Rome. This marble is fully described under the heading of Building Stones. Nine miles from Ione a white marble of good quality is found.

Butte County. A blue variety crops out for miles near Pence's Ranch; it is known to be carboniferous.

Calaveras County. Near Cave City, a beautiful marble of a pleasing, soft pearl-gray color with darker markings; takes a fine polish; is compact and without flaws; it is an elegant ornamental and desirable building stone.

El Dorado County. At Alabaster Cave a nearly white marble is found, but it has not as yet been carefully studied; a gray mottled variety from near the same locality takes a good polish, and is a good building material.

Humboldt County. Seven miles from Eureka, a handsome mottled gray marble of uniform texture; takes a high polish; soluble in acids; contains but little magnesia, and seems to be an excellent stone. It is located on the timber claim of Flanegan & Brosman.

Inyo County. Numerous marbles have been observed in the Inyo Mountains, from white to black, but little is known of them. At Big Pine, at the foot of the Sierra Nevada Range, there is a cropping of beautiful white marble, but it has never been examined chemically and may be dolomite. In Death Valley a blue limestone is found in bowlders among the float filled with what seems to be fossil coral; if cut and polished it would probably be found to be a fine marble.

Kern County. A water-worn bowlder of marble of good quality was found in the bed of Poso Creek; the source is not yet known. A brecciated marble resembling Giallo antico is found three miles from Tehachapi, and a soft yellow and really very beautiful marble is found in a valley nine miles west of the town of Tehachapi. It is found in large masses. There is one large block at the station at Tehachapi which was never shipped. The marble is fine grained and beautifully mottled. These marbles are described in detail under the head of Building Stones. They are worthy of special attention.

Los Angeles County. There are two varieties of marble known to occur in this county; one light colored, the other dark. But little is known otherwise of them.

Monterey County. Near Carmello Bay, a white compact marble is found which is said to exist in very large quantities. A company was incorporated some years ago to work it, known as the Pacific Carrara Marble Company.

Nevada County. On Bear Creek, near Colfax, a dark gray-veined marble is found. Another locality is ten miles south of Grass Valley.

Placer County. Near Clipper Gap, gray-veined marble of good quality; takes a high polish; occurs in large quantities. Analyses of two varieties are published in the fourth annual report of this office, folio 111. A white marble occurs at and near the cave, in the vicinity of Auburn.

A white saccharoidal marble is found near the iron furnaces, in section fifteen, township fifteen north, range eight east. It could be obtained in large blocks or slabs if required. An analysis may be found on folio 111, fourth annual report of this office.

A very beautiful black marble, veined with white, has been found near Colfax, on the Central Pacific Railroad. It is an excellent ornamental and building stone, and should be utilized.

A large cropping of light gray marble, with veins and markings of darker gray, has been opened in a lime quarry near Auburn. It is in very large quantity. It is compact, of uniform structure, and takes a high polish. An analysis appears on folio 111 of the fourth annual report.

Plumas County. Limestones and marbles have been found at Devil's Elbow. This office has no information as to quality or quantity.

San Bernardino County. Near Colton, in Slover Mountain, half a mile from town. The marble is white and of good quality, but I am informed that it has not yet been found of a quantity that will admit of large blocks being quarried. It is extensively burned for lime.

San Luis Obispo County. Marbles in many varieties are said to occur in this county, but this office has no special information.

Santa Cruz County. At the lime works mentioned elsewhere, a crystal-limestone is found that has some of the properties of marble.

Shasta County. Marbles are found in the Gray Mountains, along the McCloud River. No specimens have been sent to the Mining Bureau.

Tuolumne County. This county is rich in marbles and limestones. A beautiful dark marked variety is found near Abbey's Ferry; the exact locality is not known. In the bed of the Tuolumne River, at Sonora, a large water-worn outcap of a blue and white marble is laid bare in placer mining.

CARBONATE OF COPPER—see Malachite and Azurite.
CARBONATE OF IRON—see Siderite.
CARBONATE OF LEAD—see Cerusite.
CARBONATE OF MAGNESIA—see Magnesite.
CARBONATE OF SODA—see Trona.
CARNELIAN—see Quartz.

29. CASSITERITE. Binoxide of tin.

Tin has been found in at least three localities in California. In the Temescal Mountains, San Bernardino County, lies the only known deposit in the State, having a prospective value. In Plumas County, in the bed of the middle fork of Feather River, three miles above Big Bar, a single specimen was found by Mr. Thomas Lane of La Porte, and given to Professor W. P. Blake, and by him described as resembling the stream tin from Durango, Mexico. Another specimen was found some years ago near Weaverville, Trinity County, in the loose soil, and presented to Professor J. D. Whitney, then State Geologist. The vein from which it came was never found.

Grossularite, lime garnet, a common mineral in Southern California, resembles crystals of cassiterite, and has often been mistaken for it by Cornish miners. A number of reported tin discoveries have turned out to be this mineral. The temescal tin mines are in the Temescal Mountains, whence the name, on section two, township four south, range seven west, San Bernardino meridian; distant fifty-five miles east of Los Angeles, and thirty-five miles from Anaheim Landing.

CAT'S EYE—see Quartz.

30. CERARGYRITE. Chloride of silver.

Cerargyrite is rather a common mineral in some of the southern counties of the State, associated with embolite, but seldom in masses sufficiently large to form good cabinet specimens. Microscopic crystals of great beauty are not uncommon, but the mineral generally occurs in very thin crusts.

It forms the chief silver mineral in Slate Range, Inyo County. The finest microscopic crystals are found in the Modoc Chief Mine, Inyo County. Cerargyrite is a valuable silver mineral, and is easily reduced by the most simple metallurgical process.

It has lately been found in the Silver King Mine, four miles west of Redding, Shasta County. The ore contains minute, but very perfect, crystals of cerargyrite. An assay showed silver to be present to the extent of 140 ounces to the ton. The ore resembles the best from Calico District, in San Bernardino. The specimens were sent to the Mining Bureau by B. B. Miner.

31. CERUSITE. White lead, carbonate of lead, white lead ore, etc.

This mineral is very easily distinguished, and is rather common in California, seldom in crystals, but generally associated with galena, anglesite,

azurite, linarite, chrysocolla, malachite, silver minerals, and gold. Fine crystallized specimens, with the associates above mentioned, are found in the Modoc Mine, and in many other localities, in the Inyo and Coso Mountains, Inyo County; in the Russ District, in the same county, in large crystals resembling those from Siberia, and at Great Basin Mine, near Mohave River (Blake). It is a valuable ore of lead, and in certain localities an indication of silver ores. A considerable proportion of the lead ores worked at the Cerro Gordo Mines were cerusite. Thirty-two thousand tons of lead were produced in these mines.

32. CERVANTITE. Antimony ochre.

This is a rare mineral in California. It occurs with stibnite in San Emedio Mountain, Kern County. (Blake.)

33. CHALCANTHITE. Native sulphate of copper, blue vitriol.

Results from the decomposition of copper sulphide ores and is rare in nature. It sometimes occurs in old copper mines in California when the waters do not flow from the workings, and old tools such as picks, gads, hammers, etc., left by accident in the old works, have been found changed to metallic copper, or very heavily coated with that metal. Specimens in the State Museum are from the Peck Mine, Copper City, Shasta County, and from Sweetland, Nevada County.

The waters of a copper spring near Glenbrook, Lake County, deposit copper on a knife blade.

CHALCEDONY—see Quartz.

34. CHALCOPYRITE. Copper pyrites. This mineral is quite abundant in California, being found in greater or less quantities from north to south. It is a valuable ore of copper; but its metallurgy presents so many difficulties that it is found generally more profitable to concentrate it and ship it to England than to work it here. Under some circumstances it has been found economical to reduce it to a matte by a single furnace operation, and ship it in that condition. It is also worked somewhat extensively at Campo Seco, Calaveras County, and at Spenceville, Nevada County. The following California localities are represented in the State Museum:

Calaveras County. Campo Seco, Copperopolis, and Lancha Plana.
Colusa County. Stony Creek.
Contra Costa County. In the rocks of Mount Diablo.
Inyo County. Beveridge District.
Los Angeles County.
Mariposa County. Near Hornitos.
Nevada County. At Spenceville.
Plumas County. Bullion District and Light's Cañon.
San Bernardino County.
San Diego County.
San Francisco County. In specks in the jaspers of the peninsula.
Santa Clara County. At Lexington.
Shasta County. Copper City.

It occurs also in small quantities with ores of gold and silver, and is almost universal in its distribution over the State.

35. CHALCOSITE. Vitreous copper, copper glance.

It is found with other ores of copper in the State, more frequently in the southern counties. It is sometimes argentiferous, and merges into stromeyrite, which see. It occurs in the silver ores in Inyo and San Bernardino

Counties; in Genesee Valley (in basalt), Plumas County; in San Diego County; in Los Angeles County; at the Maris Mine, in grains and irregular masses, in syenitic granite, containing silver (Blake); in San Luis Obispo County; and in the Enterprise Mine, Bullion District, Plumas County.

Chessy Copper—see Azurite.

Chloride of Silver—see Cerargyrite and Embolite.

Chloro-Bromide of Silver—see Embolite.

Chloro-Carbonate of Lead—see Phosgenite.

Chrome Iron—see Chromite.

36. CHLOROPAL. Nontronite.

This mineral has been found recently at two localities in California, one near Hite's Cove, Mariposa County, and in lava at Bath, in Placer County. A specimen from the former gave the following reaction: Color, piscatio green; cuts like soap; easily indented or cut by the finger nail; lumps under the pestle; gives water in closed tube; with borax on platinum wire, gives iron reaction; on charcoal, in reducing, flame turns black and becomes strongly magnetic. Partly soluble in hydrochloric acid; dissolves in caustic soda, leaving a black residuum.

37. CHROMITE. Chromic iron, chrome ore, etc.

This mineral is very abundant in California. Its occurrence and production have been fully described in the fourth annual report, folio 126.

It is known to exist in at least twenty-six counties in the State, as follows. Nearly all the localtties are represented in the State Museum:

Alameda County. Near the Town of San Antonio; in Livermore Valley, nine miles southeast from section thirteen, township three south, range two east; 1,500 tons 48 per cent shipped to Philadelphia; 60 tons sold at $6; 500 tons offered at $5, without sacks.

Amador County. Near Jackson, one mile from Mountain Spring House.

Butte County. Mount Hope District, near Forbestown.

Calaveras County. French Gulch; near Domingo Creek; near Campo Seco; near Murphy's; in San Diego Gulch, on the east of the highest hill opposite the Noble Copper Mine, in very large masses.

El Dorado County. Two miles from Coloma; two miles northwest of Shingle Springs; ten miles west of Shingle Springs; near Latrobe.

Fresno County. Near the New Idria Quicksilver Mine; twenty miles from Fresno City.

Lake County. At Lower Lake; on the road from St. Helena to Knoxville; at Glenbrook, a large quantity. Mr. H. Aldrich thinks 1,000 tons could be obtained from this locality.

Los Angeles County. Lang's Station, Soledad Cañon; occurs with magnite, in the form of sand.

The Los Angeles papers assuming the mass to be chrome iron, estimate the quantity at 50,000 tons, which is without doubt a mistake. It is not uncommon in California to find chromite with magnetic sands, but not in such large proportion.

Mendocino County. At Stanley's Ranch.

Monterey County. Near San Benito River.

Napa County. Near St. Helena, in Chiles Valley; 170 tons delivered at St. Helena, sold for twelve dollars per ton.

Nevada County. Deer Creek, Coyote Diggings, near Colfax.

Placer County. Near Alabaster Cave, Michigan Bluffs, within one mile of Auburn, on section twelve, township fourteen north, range nine east, seven miles east of Iowa Hill.

Plumas County. Spanish Creek, Meadow Valley.

Sacramento County. Seven miles east of Folsom, near south fork of American River; nine miles from Folsom; 2,800 tons have been shipped from this locality.

San Francisco County. Several unimportant deposits are known on the peninsula, one on the ocean beach below outlet of Lake Merced, one on the hills south of the city.

San Luis Obispo County. Chrome iron is abundant in this county. The Flores deposit has been extensively worked. The Pick and Shovel Mine is six miles northeast of the town of San Luis. The London Mine is four and a half miles northeast of the town. Extensive mines lie five miles southeast of San Luis. Very large quantities of chrome ores have been shipped from this county. The county papers estimate the product at over twenty-eight thousand tons.

San Mateo County. Chrome ores are found in this county, on the Pacific Slope of the redwoods. The deposits are said to be large.

Santa Clara County. Five miles east of San José; Los Gatos.

Sierra County. Vicinity of the Mountain House, near Downieville; Cherokee Creek, one fourth of a mile southeast of Brandy City.

Siskiyou County. Half a mile from the town of Yreka—a high grade ore.

Solano County. Near Fairfield.

Sonoma County. Near Litton Springs, in large quantities; at Hood's ranch.

Tehama County. A large deposit has recently been found in township twenty-five north, and range seven west, by J. A. Heslwood; a company has been incorporated.

Tulare County. Deer Creek, near Plano, and ten miles from Portersville.

Tuolumne County. The Engel Mine at Yorktent, near Chinese Camp, has been worked for many years.

CHROME SPINEL—see Picotite.

38. CHRYSOCOLLA. Silicate of copper. Rather an abundant mineral in southern California. It is regarded in Owens' Valley as an indication of silver mines. It is found as a blue stain on ores of copper and silver, and in the vicinity of mines of these metals. Fine specimens are found in the Copper World Mine, San Bernardino County; in the Lundy Mines, Mono County, associated with ceragyrite and cuprite, and in the Union Mine, Inyo County, and forty miles south of Colton, San Bernardino County. It occurs also near San Carlos, Inyo County; at the Eclipse Mine, same county; in the White Mountains, Mono County; in San Diego and San Luis Obispo Counties, and elsewhere in the State. It is a valuable ore of copper, for the reason that it can easily be reduced in the water jacket furnace to metallic copper.

39. CHRYSOTILE. This is a magnesian mineral, a variety of serpentine, having no economic value. It occurs in veins or seams in serpentine, and is not uncommon in the State where the serpentines occur.

40. CINNABAR. There are in this State many deposits of cinnabar. The counties most distinguished for their wealth in this mineral being Santa Clara, Fresno, San Luis Obispo, Trinity, Napa, Sonoma, and Lake, all containing mines that have been more or less, and in some of which mines are still being worked. The localities are so numerous that like those of gold it would be tedious and unnecessary to mention them all. Under the head of *Mineral Springs*, it will be seen that the influences which have led to the deposition of cinnabar, pyrite, native mercury, calcite, aragonite, quartz, sulphur, bitumen, and gold, are still in active operation, and as cinnabar is the mineral from which most of the quicksilver has been extracted in California, it is proper to give under this head the following statement of the product of that remarkable and useful metal for the years 1885–6, furnished by Mr. J. B. Randoll; by referring to the same subject in former reports, the entire yield for California may be learned:

PRODUCTION OF QUICKSILVER IN CALIFORNIA FOR THE YEAR 1885–86.

(*Black figures are the production of 1886.*)

	Ætna.	Napa C.	Great Western.	Guadalupe.	New Idria.	Sulphur Bank.	Redington.	Great Eastern.	Various.	Total—flasks.	New Almaden.	Grand Total—flasks.	Price in San Francisco—per flask. Highest.	Price in San Francisco—per flask. Lowest.
January	189 **162**	131 **147**	172 **339**	0 **0**	190 **70**	24 **100**	40 **42**	37 **73**	0 **34**	783 **967**	1,700 **1,431**	2,483 **2,398**	$33 00	$32 50
February	96 **132**	180 **192**	245 **274**	35 **0**	70 **175**	85 **108**	24 **24**	75 **53**	0 **45**	810 **1,003**	1,506 **1,100**	2,316 **2,103**	$32 50	$32 50
March	88 **209**	145 **218**	314 **226**	0 **0**	80 **20**	83 **91**	0 **21**	33 **43**	19 **75**	762 **903**	1,500 **1,522**	2,262 **2,425**	$32 50	$31 00
April	142 **328**	145 **172**	340 **115**	0 **0**	80 **90**	69 **172**	0 **36**	37 **62**	0 **62**	813 **1,037**	2,003 **1,256**	2,816 **2,293**	$31 00	$30 00
May	62 **228**	190 **128**	269 **99**	0 **0**	75 **101**	194 **36**	0 **18**	0 **76**	3 **95**	793 **781**	2,000 **1,600**	2,793 **2,381**	$29 00	$28 50
June	112	250	330	0	62	91	50	63	5	963	1,750	2,713	$30 00	$29 00
July	45	191	321	0	75	209	43	50	10	944	1,750	2,694	$30 00	$29 75
August	118	175	324	0	80	150	49	0	47	943	2,104	3,047	$29 75	$29 50
September	201	180	347	0	95	85	57		77	1,042	1,936	2,978	$30 50	$29 50
October	52	185	236	0	85	123	42	65	82	870	1,598	2,468	$30 50	$30 00
November	54	190	292	0	122	61	43	43	87	892	1,576	2,468	$30 00	$29 75
December	150	235	279	0	130	122	37	43	62	1,058	1,977	3,035	$32 00	$30 00
Totals	1,309	2,197	3,469	35	1,144	1,296	385	446	392	10,673	21,400	32,073	$32 00	$28 50
Production in 1884	2,931	1,376	3,292	1,179	1,025	890	881	332	7	11,913	20,000	31,913	$35 00	$26 00
Production in 1883	*	5,890	3,869	84	1,606	2,612	1,894	1,669	101	17,725	29,000	46,725	$28 50	$26 00
Production in 1882	....	6,842	5,179	1,138	1,953	5,014	2,171	2,124	241	24,662	28,070	52,732	$29 05	$27 35
Production in 1881	....	5,552	6,241	5,228	2,775	11,152	2,194	1,065	584	34,791	26,000	60,851	$30 75	$27 90
Production in 1880	....	4,416	6,442	6,670	3,209	10,706	2,139	1,279	1,600	36,461	23,465	59,926	$34 45	$27 55

* Production of Ætna and Napa Con. not segregated in former years.

CLAY—see Kaolinite.
COAL—see Lignite.
COBALT—see Erythrite and Millerite.
COBALT BLOOM—see Erythrite.

41. COCCINITE. Iodide of mercury.
Locality given by Dana, San Emidio Cañon, Kern County.
COLEMANITE—see Priceite.

42. COPPER. Copper in the metallic state has not been found in any considerable quantity in California. The following are the known localities:

Calaveras County. Found sparingly in the Keystone, Napoleon, Lancha Plana, and Union Mines. The Satellite Mine, the Lancha Plana under a new name, has produced a fine lot of specimens which were exhibited by Horace D. Randlett at a late exhibition of the Mechanics' Institute at San Francisco.

Del Norte County. With cuprite, Pearl Mine.
Napa County. Near St. Helena.
Nevada County. Meadow Lake, with cuprite.
Plumas County. At Mumford's Hill, with rhodonite.
Sacramento County. Cosumnes Mine.
San Luis Obispo County. Pieces of float copper have been found in the Coast Range, sometimes associated with cuprite; one mass weighed 37.3 pounds.
Santa Barbara County. In grains in serpentine rocks (Blake).
Shasta County. Cow Creek and Iron Mountain.
Trinity County. With cuprite.

43. COPPERAS. Coquimbite in part, hydrous sulphate of iron, occurs in several localities in the State, and is generally the result of solfataric action, as at the Sulphur Bank, in Lake County, where it is very abundant. No analysis has been made of it, so that its exact composition is unknown. Dr. Trask, in his report of 1854, fol. 56, says it is found in large quantities near the town of Santa Cruz, in such quantity that it could be extensively manufactured as an article of commerce. I formed the same opinion as to the Sulphur Bank before mentioned. A sample of saturated solution of sulphate of iron was sent to the Mining Bureau recently, leached from ground sulphurets that the party who sent it states could be obtained at the rate of seventy gallons per ton. This is only another evidence of the enormous waste that is permitted in the metallurgy of ores in California.
COPPER—Blue Carbonate—see Azurite.
COPPER GLANCE—see Chalcosite.
COPPER—Green Carbonate—see Malachite.

44. CORUNDUM. According to Baron Richthoven it is found in the drift in the San Francisquito Pass, Los Angeles County.

45. CUBAN. Sulphide of copper and iron. It is said to be found on Santa Rosa Creek, San Luis Obispo County. One mass weighed 1,000 pounds. I consider this statement as doubtful.

46. CUPRITE. Red oxide of copper. Cuprite is rather a common mineral in California. The following are the most important localities:
Colusa County. Candace Mine.

Del Norte County Pearl Copper Mine, with native copper.

Kern County. San Emedio Ranch, with malachite.

Mono County. Kerrick Mine, with azurite, malachite, partzite, and native silver.

At Lundy, in microscopic crystals, with cerargyrite and chrysocolla.

On the borders of Mono Lake and at Mammoth.

Napa County. Near St. Helena, in masses of considerable size, with native copper.

Nevada County. At Meadow Lake, with native copper.

Placer County. Near Lincoln.

Plumas County. Reward Mine.

Shasta County. Peck Mine, Copper Hill, in microscopic crystals.

Trinity County. With native copper, exact locality unknown.

Tulare County. May Flower Mine, Mineral King District.

And at numerous localities in the Inyo Mountains, Mono, and Inyo Counties.

According to Blake, it occurs sparingly in thin crusts and sheets with the surface ores of the principal copper mines in Calaveras County, especially the Union and the Keystone; in Mariposa County, at La Victoire Mine, with green and blue carbonates of copper; in Del Norte County, at the Evoca, Alta, and other mines, in very good cabinet specimens, the cavities being lined with crystal; in Plumas County, and in the upper parts of most of the copper veins of the State.

47. CUPROSCHEELITE. Tungstate of lime and copper. This new and interesting mineral was first found in California in the Green Monster Copper Mine, in Kern County, about twelve miles east of White River Post Office. It is generally associated with black tormaline. A large crystal was found at this locality, which is the only one of this mineral known. In 1879 a fine specimen was sent to San Francisco from Fresno County, but the exact locality was not given.

48. DATOLITE, OR DATHOLITE. This mineral has, as yet, been found at one locality only, but from the universal distribution of boracic acid in the State, it is likely to be found elsewhere. The locality is a mining tunnel near San Carlos, Inyo County. It occurs with grossularite in fine crystals, the datholite being the matrix in which the grossularite is embedded. This mineral was first noticed by the late J. Lawrence Smith, and an account of it published in the *American Journal of Science* a number of years ago.

49. DIALLOGITE. Rhodochrosite, carbonate of manganese. This mineral is represented in the State Museum by a single specimen, No. 3584, in beautiful pink crystals, from the Colorado Mine, No. 2, Monitor District, Alpine County.

50. DIAMOND. For the details of the occurrence of diamonds in California, and of general history, the reader is referred to the fourth annual report of this office, folio 157. The following are the known localities in the State:

Amador County. A very interesting stone was found in July, 1883, by George Evans, on the surface of the ground at Rancheria, a small mining camp, about four miles northwest of Volcano. It weighs about 255 milligrams. Its length is 0.315 inches; thickness, 0.215 inches. It is irregularly globular in form, all the faces being convex. It is pale straw colored, very

brilliant, and, as far as can be distinguished even under the microscope, is without a flaw. Jackass Gulch, near Volcano, and Indian Gulch, Gopher Hill, near Fiddletown, and other localities. Diamonds have been found at Volcano in a peculiar volcanic formation, described by Professor Whitney as "ashes and pumice cemented and stratified by water." The crystals had the form of the icositetrahedron, with faces curved in the manner peculiar to the diamond.

Butte County. A fine crystal was found some years ago in the west branch of Feather River. It was about four millimeters in diameter. It was afterwards lost. A number of diamonds have been found at Yankee Hill, but the exact number is not known.

A fine diamond from the Spring Valley Mine, Cherokee, has been presented to the State Museum, No. 4033, by Mr. G. F. Williams, Superintendent. Mrs. Harris has a beautiful Cherokee rough diamond set in a ring. Mr. Harris, who was formerly Superintendent of the Spring Valley Hydraulic Mine, has another, which has been cut. Of the two, I consider the natural crystal the most interesting and beautiful. Mrs. W. C. Hendricks of Morris Ravine, near Oroville, also has a fine Cherokee diamond set in a ring.

In August of 1883 I visited Cherokee, Butte County, specially to study that celebrated diamond locality. Mr. A. McDermott, druggist of Oroville, says that a diamond was sent to him in 1862 which was as large as a small pea. It was nearly globular and obscurely crystallized and of yellow color. He does not know the subsequent history of the stone, where it was found, or the owner's name.

At Cherokee, diamonds and zircons are found in cleaning up sluices and undercurrents. The first notice of diamonds at this locality dates from 1853, the largest discovered, which was two and a quarter carats (nine grains), is now in the possession of John More. There have been from fifty to sixty found, from first to last; some were rose colored, some yellow, others pure white, and all associated with zircons, platinum, iridium, magnetite, gold, and other minerals.

El Dorado County. Mr. W. A. Goodyear is quoted in Whitney's "Auriferous Gravels of the Sierra Nevada of California" as follows: "He saw a diamond in the possession of Mrs. Olmstead, at Dirty Flat, near Placerville, which measured nine thirty-seconds of an inch maximum diameter, and weighed one and a quarter carats—$5\frac{61}{100}$ grains. It was found by Mr. Olmstead in cleaning up the sluices of the Cruson tunnel, Dirty Flat.

At the McConnell & Reed claim, on the south side of Webber Hill, a diamond the size of a small white bean was found. This diamond was discovered a few feet above the bedrock. Mr. McConnell thinks on a previous occasion he had thrown away a diamond as large as the end of his thumb, in ignorance of its true character. Two other diamonds were found in another claim, also on the south side of Webber Hill.

Three or four diamonds were found near White Rock. Mr. Goodyear purchased a crystal of Mr. Thomas Potts. It weighed half a carat—two grains; had a slight yellowish tinge, and was found in washing the gravel which came from a tunnel driven into White Rock. Near the same locality three diamonds were found in gravel by the Wood Brothers, in 1867. The largest was valued by a San Francisco dealer at fifty dollars.

An interesting letter from Placerville to the State Mineralogist, from W. P. Carpender, gives much information on this subject. It is published in full in the fourth annual report, folio 169.

Nevada County. French Gulch—one crystal weighed 7½ grains.

Trinity County. An examination of the platinum sands of the Trinity

River was made by Professor F. Woehler, of Gottingen, who found diamonds in them. After removing gold, platinum, chromic iron, silica, rhuthenium, etc., by the usual methods, he examined the residue microscopically, and observed colorless, transparent grains, which he presumed to be diamonds. Subsequent combustion in oxygen and precipitation from solution of baryta, by the carbonic acid evolved, convinced him that the microscopic crystals were true diamonds.

DIATOMACEOUS EARTH—see Quartz.

51. DOLOMITE. Carbonate of lime and magnesia. Inyo marble.

Dolomite is rather abundant in California. The following are the most important localities at present known:

Amador County. In narrow, snow-white veins, traversing talcose and chlorite rock bearing coarse, free gold. (Blake.)

Calaveras County. In the Winter, Hill's, and other mines, with quartz and free gold, sometimes in cavities, in fine crystals. (Blake.)

Inyo County. Dolomite is very abundant in the Inyo range of mountains, from White Mountain to Coso, and in very large deposits. The White Mountain Peak is named from its white appearance. The summit, which seems to be of this rock, is often supposed to be covered with snow, when it is not. Attention has lately been called to the white variety of this marble, which resembles the finest Carrara marble, from which the name "*Inyo marble*" has been taken. A technical description of this dolomite marble has been given under the head of Building Stones.

Los Angeles County. Tejunga Cañon, San Gabriel Mountains.

Mendocino County. Exact locality unknown.

Napa County. Mount Catherine.

Plumas County. With pyrite at Mumford's Hill.

San Bernardino County. In the Armagosa Mines, with free gold; also in the wash of the Armagosa River, in white bowlders, which, broken, resemble the finest Italian marble.

San Luis Obispo County. At Morro, in nodules resembling fossil coral; from less than an inch to several feet in diameter. Some have cavities lined with crystal.

52. DUFRENOYSITE. A mineral composed of sulphur, arsenic, and lead. Said to be found in the Union Mine, Cerro Gordo, Inyo County (doubtful).

ELECTRUM—see Gold.

53. EMBOLITE. Chloro-bromide of silver. It is rather an abundant mineral in southern California, but is seldom found in masses of any considerable size, being generally disseminated throughout the other ores of silver, or occurring in crusts. It is almost always associated with cerargyrite, for which it is often mistaken. It is found in the Minnie Mine, Sweetwater Range, Mono County, and in the Indiana Mine, near Swansea, Inyo County. A large specimen of silver ore in the State Museum (brecciated), a large portion of which is covered with embolite, is from the Alhambra Mine, Calico District, San Bernardino County.

EMERALD NICKEL—see Zaratite.

54. ENARGITE. Sulpho-arsenide of copper, sometimes containing antimony, iron, silver, or zinc. It occurs at least at one place in California, where it is abundant, associated with pyrite and other minerals. It has a disposition to change to arsenious acid and sulphate of copper, a reference

to which has been made under the head of arsenolite. The locality is the Morning Star Mine, Monitor District, Alpine County, from which there are fine specimens in the State Museum. One remarkably fine specimen from the Stella Mine was presented by Lewis Chalmers. It is a nodular mass, surrounding a nucleus of pyrite. It is coated white on the surface from the decomposed mineral. The inner nucleus is in part amorphous, partly crystalline, of a pale gray color; where it joins the enargite it is pale yellow.

55. ENSTATITE. Bronzite.
Silicate of magnesia, alumina, iron, lime, manganese, etc. The variety Bronzite is found in Alameda County, in the Berkeley Hills.

56. EPIDOTE. Silicate of alumina, lime, iron, etc. Occurs sparingly in California, at Long Valley, on the Mohawk Road, Plumas County, and in Miners' Ravine, Placer County. It has been found with copper ores in Calaveras and El Dorado Counties, but the exact localities are uncertain.

57. EPSOMITE. Epsom salt, hair salt, sulphate of magnesia.
This rather rare mineral occurs in the Redington Quicksilver Mine, Napa County, in curved porous crystals several inches long, white color, nearly wholly soluble in water, gives much acid water in closed tube, and a black sublimate of sulphide of mercury which is present as an impurity. B. B. on ch. melts in its water of crystallization, and becomes pink on addition of nitrate of cobalt at a red heat.

A qualitative analysis shows it to contain alumina and traces of iron. The small residue left after solution in water was examined microscopically and found to consist of black, yellow, and transparent particles, some sulphide of iron (pyrites), and a small amount of cinnabar. The black particles proved to be magnetite, the yellow free sulphur, and the transparent, selenite—altogether an interesting association, and one that will be studied more carefully in the future.

Epsomite has been found in an old drift in Ventura County, at Rincon. The tunnel is in two hundred to three hundred feet, and the mineral forms on the roof and sides in acicular needles two inches long. Specimens have been presented to the State Museum by Dr. Stephen Bowers, of Ventura. It is very soluble in water.

ERUBESCITE—see Bornite.

58. ERYTHRITE. Arsenite of cobalt.
This rare mineral has recently been found in California and Nevada. It is found as a rose-red incrustation on a grayish earthy mineral at the Kelsey Mine, Compton, Los Angeles County. It was described by Professor William P. Blake in "Contributions to the Mineralogy of California," in the appendix to the second annual report of the State Mineralogist, 1882.

FELDSPAR—see Albite, Labradorite, and Orthoclase, and special paper on rocks and building stones.

59. FLUORITE. Fluor spar, fluoride of calcium.
Found only sparingly in small white cubes, with copper ore, at Mount Diablo, Contra Costa County (Blake).

FLUOR SPAR—see Fluorite.
FRENCH CHALK—see Talc.
FREIBERGITE—see Tehahedrite.

60. GALENA. Galenite, sulphide of lead.

Galena is a common ore of lead and very abundant in California. It is found in the northern part of the State with pyrite and blende, in the gold mines, and in the south with silver ores; sometimes disseminated through the ore, at other times in distinct veins, and in masses of considerable size. The time will come when by a proper system of concentration this mineral will be gathered and will add largely to the lead production of the world.

The following are some of the very numerous localities in the State; most of them are representated in the State Museum:

Amador County. Rising Sun Mine, near Aqueduct City.

Calaveras County. At Murphy's, in the Star of the West Mine, Blue Mountain District and Gold Hunter claim.

Inyo County. New Coso, Modoc, Brown Monster, and Hidalgo Mines, the latter showing radiated structure. In the Cerro Gordo Mines where a large quantity of lead has been produced, and at many other localities in the Inyo Mountains. All the ores containing this mineral are argentiferous.

Mariposa County. Marble Springs.

Mono County. In the May, Lundy, and Homer Districts, and with native silver and partzite, Tower Mine near Benton; there are numerous other localities in the county.

Nevada County. In several of the most noted mines with gold, and at Meadow Lake with gold and blende.

Plumas County. Light's Cañon and Granite Basin.

Sacramento County. At Michigan Bar, with blende and pyrites.

San Bernardino County. In many localities.

Santa Catalina Island.

Tehama County. At Cow Creek.

Tuolumne County. In white quartz, with coarse gold, pyrite, and blende; Soulsby Mine.

61. GARNET. Andradite.

Garnets are found in a number of localities in California, but no stones suitable for jewelry work, or which should be called gems, are known.

Garnets have been found in the following localities in the State:

Calaveras County.

El Dorado County. At Fairmount Mine, three miles from Pilot Hill, in large blocks and masses two feet thick or more (Blake); Rogers' claim, Hope Valley, with copper ores.

Fresno County. Near New Idria (chrome garnet).

Inyo County. Coso Mining District. Specimens have been brought to San Francisco, under the impression that they were tin ore.

Los Angeles County. Mountain Meadows, with copper ores.

Marin County. Reed's Ranch, in mica schist.

Mono County. Near Mono Lake.

Plumas County. Long Valley.

San Bernardino County. Near the Temescal Tin Mines.

San Diego County. Soledad Mine, near Santa Ysabel.

Santa Clara County. Thirty miles northeast of San José, in mica schist.

Sonoma County. Mouth of Russian River—near Petaluma, associated with specular iron, pyrite, chalcopyrite, calc spar, actinolite, and steatite.

Ventura County. Pine Mountains.

62. GAY-LUSSITE. Carbonate of lime and soda, found in alkaline lakes in fine crystals. It has no present economic value. Thinolite, which

forms mountains in Nevada and elsewhere in the Great Basin, is believed to be a pseudomorph after gay-lussite; if this is so, the quantity of carbonate of soda set free must also have been very great. This subject forms the substance of several chapters in the "Geology of the Fortieth Parallel," Clarence King. Gay-lussite is found in California at Borax Lake, San Bernardino County, and probably elsewhere.

63. GEOCRONITE. Sulphide of lead and antimony, has been observed with galena in small masses in the Inyo Mountains, Inyo County. A specimen was exhibited in the California collection at the Paris Exposition of 1878.

64. GLAUBERITE. Sulphate of lime and soda, was found at Borax Lake, Lake County, in blue clay at a depth of forty feet, having been obtained in an artesian boring (Dana). It is reported also in San Bernardino County, at the borax works, and it is said to exist at the Geysers in Sonoma County.

65. GLAUCOPHANE (Wichtisite). This mineral occurs in a rock matrix, widely distributed in California, and associated with serpentine. The rock was first observed in 1877, when sections were cut for microscopic observation. A specimen was exhibited at the Paris Exposition of 1878, and when seen by M. Michel Levy was recognized as the "Mica schiste a glaucophane de Syra, Greece," figured in his "Mineralogie micro-graphique des Roches Eruptive Françaises," planche 1, Fig. 2. This rock is represented in the State Museum by No. 4259. The wall rock of the Collier Mine, six miles northeast of Murphy's, Calaveras County, and microscopic slide from near the Wall Street Quicksilver Mine, Lake County. A slide from this was exhibited in Paris.

66. GOLD. Gold exists in nearly every county in California. To enumerate all the localities in detail would be useless. All the information this office has been able to gain concerning this most valuable of all metals may be learned by consulting previous reports of the State Mineralogist, the museum catalogues, and a special paper in this volume.

A very interesting specimen of gold imbedded in a quartz crystal has been exhibited at the State Museum. The following description is the result of a careful examination of this curious and interesting association. It is from Tuolumne County, and was one of several obtained at the same locality. It is now in the private collection of Mr. J. Z. Davis.

The gold is, within and without the crystal, projecting from a perfect face. It does not fill a cavity, but extends like a diaphragm through the quartz. The length of the quartz crystal is 42 millimeters, thickness 13 and 20 millimeters; weight, 14.670 grams; specific gravity, 2.699. According to the table given in Phillips' Metallurgy of Gold and Silver, the proportion of gold is .0429, or by weight—

Gold	0.629
Quartz	14.041
Total	14.670

Attached to the large crystal are two smaller ones, of smoky quartz, joined to the larger one by the gold. One of these crystals is very minute, the other is somewhat larger; the diameter of the smaller is, in decimals of an inch, .003, the larger is .0375.

The gold is bright, crypto-crystalline, leaf-like, curved in some parts like the gold found in some quartz mines in the State, specially the Cedarberg. The large crystal of quartz is well terminated at one end; the base is shattered and irregular. At the junction of the gold with the quartz the quartz is somewhat fractured, but the gold extends into the body of the crystal into the solid quartz. The face of the crystal which appears fractured, when examined under the microscope, seems to be a confused conglomerate of imperfect crystals of quartz in which some minute half-formed crystals of gold are imbedded. It is interesting to speculate as to the manner of the formation of this crystal, and to theorize how the gold came to be imbedded in it. At first thought it would seem to be conclusive that the gold was formed first and that the quartz crystallized about it; but they may be cotemporaneous, another evidence that quartz is deposited in a gelatinous state, from which it hardens into massive and even crystalline quartz.

It has long been known that gold existed in small quantities on the peninsula of San Francisco, within the city limits. A handy panner, or one skilled in the use of the improved batea, can at any time obtain one or more colors of gold in a panful of sand from the ocean beach or the shores of San Francisco Bay. A few ounces of gold have been extracted from the black sands on the beach near Lake Merced. A small portion of this gold has been obtained, rolled out into a ribbon, and placed in the museum as a specimen of gold from San Francisco County. It has been numbered 6530 in the museum catalogue. Some day this specimen will be prized as a relic of the golden era in California. Half an ounce of gold should be bought from every county in the State while it is possible, and carefully preserved in the State Museum.

67. GRAPHITE. Plumbago, black lead, etc.

The following are the known localities in the State:

Alpine County. Near Summit City.

Calaveras County. Near Big Tree Grove, in crystalline scales (Blake), probably molybdnite, for which it is frequently mistaken.

Fresno County. At Borer Hill.

Kern County. Near Fort Tejon.

Los Angeles County. Tejunga Cañon, twenty-five miles from Los Angeles, and twelve miles from S. P. R. R.

Sonoma County. Knights Valley, Guerneville, and near Pine Flat.

Tuolumne County. One mile south of Sonora, Gold Springs.

And reported in Marin, Plumas, and Sierra Counties.

No deposit of any considerable value has as yet been found in the State, and the quality is very inferior. Some of the specimens from localities given above, may be molybdenite, and this is even probable.

Gray Copper—see Tetrahedrite and Chalcosite.

68. GROSSULARITE. Lime garnet.

Is quite abundant in California, especially in the southern counties, where it has often been mistaken for tin by Cornish miners who have seen it, and several tin excitements have had their origin in this mistake. It is found also with copper ore in the Roger's claim, Hope Valley, El Dorado County (Dana), and, with datholite, near San Carlos, Inyo County.

69. GYPSUM. Alabaster, selenite, satin spar, plaster of Paris.

Gypsum is an abundant mineral in California. It has been found in numerous localities as follows:

Alameda Countg. Union Salt Works, a deposit left in the tanks in the preparation of bay salt.

Kern County. With stibnite in the Antimony Mines, San Emidio, near Breckenridge, Buena Vista, and Posa Creek.

Los Angeles County. Near the entrance of Soledad Cañon, and at a locality recently discovered.

Monterey County. Several unimportant localities.

Nevada County. Near Truckee Pass.

San Diego County. One or two miles from Elsinore, near Dos Palmas Station, banks of Carizo Creek.

San Luis Obispo County. Arroya Grande Mountains.

Santa Barbara County. With anhydrite.

The deposit in Santa Barbara County is of great excellence and very extensive, possesses the further advantage of being located within two miles of Point Sal, a shipping station on the coast for this portion of the county. This gypsum is of the white or Nova Scotia variety, being a kind well suited for making plaster of Paris, and which is said to occur abundantly at only a few other points in the United States. Since the discovery three years ago, five thousand tons have been brought to San Francisco and manufactured by Lucas & Co., who inform me that the supply cannot be exhausted in many years.

Stanislaus County. Near Hill's Ferry.

Ventura County. Ojai Ranch, Lockwood Creek.

ALABASTER—

Los Angeles County. Arrŏyo Grande, San Luis Obispo County, and Point Sal, Santa Barbara County.

Sonoma County. In fine crystals, Santa Rosa.

San Luis Obispo County. Cholame.

SELENITE—

Kern County. Antimony mines, San Emidio; Buena Vista.

Lake County. Robinson's Ranch.

Lassen County. Near Susanville, in large slabs.

Los Angeles County. Soledad Cañon, in large slabs.

Mariposa County. Bear Valley.

San Bernardino County. At and near Calico.

San Diego County. Dos Palmas Station, Southern Pacific Railroad.

Santa Barbara County. Point Sal.

Santa Clara County. Near Gilroy.

Stanislaus County. Near Modesto.

Ventura County. Lockwood Creek.

SATIN SPAR—

San Bernardino County, and Tulare County, near White River.

70. HALITE. Common salt.

The manufacture of salt was described in a special paper in the second annual report of the State Mineralogist. Since that report was published, several new salt springs have been discovered, and in sinking wells for petroleum salt water frequently rises.

Salt is known to exist in a mineral state in the following counties of the State: Alameda, Inyo, Kern, Los Angeles, Marin, Placer, San Bernardino, San Diego, Santa Clara, and others. In Inyo, Kern, San Bernardino, and San Diego Counties, it occurs in the great deserts and in the sinks of rivers which have no outlet to the sea. In Inyo County it is abundant in Owens', Saline, and Death Valleys, associated with borax, gay-lussite, hanksite, thenardite, iron, and ulexite. In Saline Valley, rock salt was discovered in

1864, in extensive beds. Large beds of salt have recently been discovered in the Alkaline Lake or sink in the Colorado Desert, in San Diego County, which are now being successfully worked by an incorporated company under the name of the New Liverpool Salt Company.

In *Alameda County* solar salt was found by the early settlers on the shores of the bay of San Francisco.

In *Kern County* it occurs fourteen miles from Cañada de los Uvas, where the ground is impregnated with salt; also in the Tehachapi Valley.

Salt springs occur in *Inyo County*, in numerous localities.

Los Angeles County. Fourteen miles from Los Angeles.

Placer County. Near Clipper Gap, and elsewhere in the State.

71. HANKSITE. This new mineral has been fully described in the fifth annual report of this office, folio 62 to 66. It has lately been discovered that it occurs in very large quantities and in a different form at the same locality, where the hexagonal crystals were found, and that a confused mass of dogtooth crystals in the State Museum are another form of hanksite. When this became known a doubt arose whether thenardite existed at all in California, but it was found that a massive variety, called *ice* by the borax miners, gave no reaction for carbonic acid and *all* the reaction for thenardite. It will be interesting when the Winter overflow of water at the locality in San Bernardino County subsides to obtain all the varieties, and to make a careful study of them. It is my opinion that instead of being a scarce mineral, hanksite will be found in great abundance, and that it will be proved that it plays an active and important part in the metamorphosis that produces gay-lussite, thinolite, and perhaps borax. Hanksite is known to occur in California in the borax fields in Death Valley, Inyo County, and in San Bernardino County, at the original locality. There are several known localities in the State of Nevada.

72. HEMATITE. Specular iron, micaceous iron, red hematite, sesquioxide of iron.

The reader is referred to a special paper on iron ores in fourth annual report, folio 232. Hematite is found in the following counties and localities in the State:

Alameda County. Near Alameda.

Alpine County. At Monitor.

Amador County. Ione Valley, near the Amador Gold Gravel Mine, two and a half miles northeast of Jackson.

Butte County (Micaceous). Feather River, near Oroville.

Calaveras County. Near Campo Seco, opposite section three, township four north, range ten east; near San Andreas—near the big tree grove.

Del Norte County. Kelsey tunnel, fourteen miles southeast of Crescent City.

El Dorado County. Diamond Springs township.

Inyo County. Owens Valley.

Napa County. Near St. Helena.

Nevada County. Holden ledge, township fifteen north, range seven east; large quantity; 1,000 tons shipped to San Francisco.

Placer County. Clipper Gap Iron Mine, on section twenty-four, township thirteen north, and range eight east; Red Hill, on section fifteen, same township and range.

Plumas County. With magnetite, near Crescent Mills; Mumford's Hill, and Light's Cañon.

San Luis Obispo County. Harrington Iron Mine, township thirty-one south, ranges eleven and twelve east.

Shasta County. Near Shasta.

Sonoma County. Specular iron, equal to that from Elba.

73. HESSITE. Telluride of silver. A single specimen was obtained in 1854, near Georgetown, El Dorado County. It had been washed out from the gold drift, and the parent vein has never been found (Blake).

HORNBLENDE—see Amphibole.

HORNSILVER—see Cerargyrite.

HORSEFLESH COPPER ORE—see Bornite.

HYALITE—see Opal.

74. HYDROMAGNESITE. A mineral, supposed to be hydromagnesite (no analysis), is found in the serpentines on the peninsula of San Francisco, and elsewhere in the State. It is represented by specimen No. 1320, in the State Museum.

ICELAND SPAR—see Calcite.

IDOCRASE—see Vesuvianite.

IDRIALITE—see Petroleum.

ILMENITE—see Menaccanite.

IODIDE OF MERCURY—see Coccinite.

IONITE—see Lignite.

75. IODINE. Dr. Trask found free iodine and bromine in the serpentine rocks at Point Lobos, San Francisco. ("Report on the Geology of the Coast Mountains, etc., J. B. Trask, State Geologist, 1854," fols. 26 and 92.) About seventeen years ago I made an analysis of mineral water containing a large quantity of iodine. The sample was furnished by Mr. Fargo, of San Francisco, who has since informed me that the spring from which it was taken was at the entrance of Grizzly Cañon, Lake County, five or six miles from Wilbur Springs. In a letter by Dr. John A. Veatch, quoted in the third annual report of the State Mineralogist, 1883, fol. 17, he writes: "Nothing of much importance presented itself until reaching the saline district, about eighty miles south of Red Bluff. It is on one of the branches of Stony Creek. Valuable salt springs exist here. The waters contain the borates in minute quantities, and one spring was remarkable for the enormous proportion of iodine salts held in solution."

76. IRIDIUM. Iridium has been found with gold and platinum in all the stream washings or placer mines of California; also in the auriferous beach sands. As not much effort has ever been made by the miners to save it, the quantity collected in this State has not been large. During the earlier stages of gold washing, when operations were prosecuted on a more extended scale, the miners finding this troublesome stuff in their sluices, where its great weight had retained it with the gold, were at much pains to separate it from the latter, after which, being ignorant of its value, the most of it was thrown away. Afterwards, when the miners found out what it was, they began to save this metal, and small lots, finding their way to San Francisco, were sold at such prices as happened to be offered for it, there being no regular purchasers in this market.

In melting gold in the United States Mint in San Francisco, and in the bullion refineries of the State, much iridium was collected which rose to the surface of the melted gold, and was skimmed off with the flux or dross. At the San Francisco Assaying and Refining Works, under the

management of Kellogg & Hewston, large quantities were so collected. The principal localities in the State where it has been found will be given under the head of platinum.

IRIDOSMINE—see Iridium and Platinum.

IRON GARNET—see Garnet.

IRON AND IRON ORES—see Hematite, Limonite, Magnetite, and Siderite. This subject has been somewhat fully treated in the fourth annual report of this office, folio 232.

ISINGLASS—see Mica, Brolite, and Muscovite.

77. JAMESONITE. Sulphide of antimony, lead, iron, copper, and zinc.

This mineral is represented in the State Mnseum by a single specimen, No. 2262, from Mokelumne Hill, Calaveras County.

JASPER—see Quartz.

78. JEFFERISITE. A mineral resembling mica, which is a hydrous silicate of numerous bases, principally alumina, iron, and magnesia. Specimens in the State Museum are (2126), from Susanville, Lassen County, and (4911), from Tulare County.

79. KAOLINITE. Including all varieties of clay resulting from the decomposition of feldspar. The numerous deposits of clay in the State and the condition of the pottery manufactures have been described at some length in the fourth annual report of the State Mineralogist, folio 139, to which the reader is referred for details. Clays are very abundant in the State, while some are admirably adapted for the manufacture of the finer quality of porcelain, others are useful only for the making of bricks. The following are the most important localities in the State, of the better quality; the inferior kinds are too numerous to mention:

Alameda County.

Amador County. Ione Valley, near Jackson.

Calaveras County.

Contra Costa County. Mount Diablo.

El Dorado County. Dutch Creek, twenty miles northeast of Placerville.

Humboldt County.

Inyo County. One deposit said to have an area of forty acres, ten feet thick; another opposite Independence.

Los Angeles County.

Marin County. Duncan's Mills.

Mendocino County. Near Point Arena.

Monterey County.

Napa County.

Nevada County. Seven miles southeast of Grass Valley, on section three, township fifteen north, range nine east, a large and very important deposit. Another is found on Rush Creek, three miles from Nevada City.

Placer County. Spinks' coal mine at Lincoln, one of the most important localities in the State; found also near Clipper Gap.

Sacramento County. Michigan Bar and Cook's Bar are important deposits.

San Bernardino County. In 1883 a deposit of very pure white kaolin of great value if in sufficient quantity was discovered at Calico.

San Diego County. Several large deposits have been found within six miles of Elsinore. Potteries have been established which are working the clay successfully.

Santa Clara County. Near San José.

Shasta County.

Sonoma County. Two miles from Santa Rosa.
Tehama County.

80. LABRADORITE. Feldspar.
This mineral has been observed in small quantities in street pavement blocks in San Francisco; the exact locality is not known.

81. LEAD AND LEAD ORES. See also galena, anglesite, and cerusite.
In the fourth annual report of this office, folio 244, the reader will find published a special paper on this subject. Metallic lead was said to have been found in a placer mine at Magalia, Butte County, in 1867. This was probably flattened bullets, which are very frequently if not invariably found in the clean up of hydraulic mines.

82. LENZINITE. Hydrous silicate of alumina.
MOUNTAIN BUTTER. Found in cavities in rocks at the mouth of Pine Creek Cañon, Alabama Range, Owens Valley, Inyo County. (Aaron.) This mineral is probably lenzinite.

83. LEPIDOLITE. Lithium mica.
This beautiful mineral has recently been found in California, at several localities, with erythrite and rubellite. It is a pink colored, scaly mineral, containing from two to six per cent of lithium. The California mineral has not yet been analyzed. It might, at some future time, be found profitable to extract lithium from it. The salts of lithium are principally used in fireworks and in medicine. The California localities are represented in the State Museum by Nos. 1229, San Diego County; 2773, twenty miles southwest of Colton, San Bernardino County; and 4262, with azurite, from the Half Dollar Mine, Inyo County.

84. LEUCOPYRITE. Arsenical iron.
Said to occur in Los Angeles County; exact locality not given.

85. LIGNITE. Brown coal, mineral coal, ionite, peat, etc.
One of the most pressing wants of California at the present time is extensive and accessible beds of good coal. It will be difficult, if not impossible, to compete otherwise with eastern manufacturers, who can purchase an unlimited supply of greatly superior fuel for less than one third the price paid by the same class of manufacturers on the Pacific Coast. The question of fuel becomes a very serious one when extensive manufactures on the Pacific Coast are contemplated.

While our mineral fuels of this class are neither cheap, abundant, nor of good quality, they serve a useful purpose, and are somewhat largely utilized. Even the brea, or crude asphaltum, is burned under steam boilers in some parts of the State.

As carboniferous rocks are known to exist in several parts of the State, there is reason to hope that true coal may be eventually found. The reader is referred to a special paper on the mineral coals of the Pacific Coast, on folio 265, fourth annual report of this office. The following California localities are known:

Alameda County. Corral Hollow.
Amador County. Ione Valley, in a vein of inferior quality, five to fifteen feet in thickness; several thousand tons have been burned in locomotives.
Butte County.
Calaveras County. Near Lancha Plana.

Contra Costa County. Mount Diablo, extending ten to twelve miles along the northern slope of the mountain; the most prolific locality in the State.

Fresno County. Six miles westwardly from the New Idria Quicksilver Mine.

Humboldt County. Near Eureka, on Eel River, thirty miles from Eureka, one hundred and fifty feet above the bed of the river; said to be a well defined and extensive bed of coal.

Kern County. Tejon Pass.

Lassen County. Near Bieber.

Los Angeles County. Four miles from Fulton—Santa Clara Coal Mine.

Mendocino County. Middle fork of Eel River, eight miles south of Round Valley—Willits.

Mono County. A vein six inches thick, twenty-five miles from Bodie.

Monterey County. South of Carmello Bay.

Placer County. At Lincoln, a very poor quality; it has been used, to a limited extent, for making steam.

San Benito County. Cienega del Gabilan Rancho, in the mountains east of Soledad.

San Bernardino County. Temescal Mountains, twenty-five miles west of Colton, Cajon Pass, said to be a fifteen-foot vein; if an analysis published in the San Diego *News* is correct, the coal is of superior quality.

San Diego. Croppings of coal or lignite were known in this county many years ago. R. C. Taylor, in his statistics of coal, published in 1855, but written before 1851, mentions the occurrence of coal on the seacoast, twelve miles north of San Diego, and the fact that the tooth of a saurian and amber were found with it. According to the statements of Dr. Le Conte, the vein is four feet thick. The writer also asserts that brown coal is found between San Diego and San Luis Rey (folio 497). According to the *Mining and Scientific Press*, coal occurs near the harbor of San Diego, on Point Loma (vol. 16, folio 81). A vein of lignite has been found four miles from Elsinore. It has been named the Cheney Coal Mine. It is developed to the extent of fifty feet, and is used as a cheap fuel. I have made an analysis which has not before been published.

ANALYSIS.

Fixed carbon	39.94	Inflammable	85.00
Volatile combustible matter	45.06		
Water	5.80	Non-inflammable	15.00
Ash	9.20		
	100.00		100.00

Streak, brown; does not cake or coke.

San Francisco County. Ore specimen found on Telegraph Hill had the following composition:

Combustible matter and water	75.7
Ash	24.3
	100.00

Another from the cemetery grounds, Presidio:

Fixed carbon	47.55
Volatile combustible matter	7.30
Water	4.40
Ash	40.75
	100.00
Inflammable	54.85
Non-inflammable	45.15

Small croppings of lignite are known to occur on the ocean beach.

San Luis Obispo County. Near the town, lat. 35° north; discovered 1847 (Statistics of Coal, R. C. Taylor, folio 497).

Santa Clara Countg. Near Lexington.

Santa Cruz County.

Shasta County.

Siskiyou County. Eight miles north of Yreka, on the road to Linkville.

Solano County. Southwestern part.

Sonoma County. Santa Rosa Valley.

IONITE—Described in fourth annual report, occurs in at least four localities, in Ione Valley, the original locality, and in San Benito County at the Coal Mine Mountains, east of Soledad. Among the asphaltum beds at Sargent's ranch, Santa Clara County, and in Los Angeles County near Petrolia, it seems to be some obscure pseudomorth after petroleum and to have a common origin.

LIME—see Calcite.

LIME GARNET—see Grossularite.

LIMESTONE—see Calcite, and special paper on Rocks and Building Stones.

86. LIMONITE. Limonite is rather an abundant mineral in California, being found in numerous localities with other iron ores in the State. The following are the principal and most important ones:

Alameda County. Five miles from the town of Alameda.

Calaveras County. Between Jenny Lind and Campo Seco, San Andreas, near the Big Trees, Sheep Ranch District, near Murphy's.

El Dorado County. Near Latrobe. For description, see Catalogue No. 4148.

Placer County. Forest Hill. In nodules resembling coprolites.

San Luis Obispo County. Harrington Iron Mine, on subdivision of Rancho Cañada de los Osos.

Santa Clara County. With psilomelane.

Shasta County. Iron Mountain Mine, seven miles from Shasta.

Sierra County. At or near Gold Lake.

Solano County. Shores of the bay, in nodules.

Tulare County. Twenty-five miles from Visalia.

YELLOW OCHRE—

Calaveras County. Near Campo Seco.

El Dorado County. Twelve miles northeast of Shingle Springs, section thirty-two, township twelve north, range eleven east, four miles east of Georgetown.

San Diego County. Two miles from Elsinore.

Santa Clara County. Near the Mission of San José.

87. LINARITE. Cupreous sulphate of lead, cupreous anglesite.

This mineral, at first mistaken for azurite, is found in considerable abundance in the silver lead mines of Cerro Gordo, Inyo County, and at the Modoc Mine, in the same county. Some of the specimens obtained are very beautiful.

88. LITHARGE. This substance has been found in San Bernardino County. It is probably a furnace product, made in prehistoric times. It has been found also in Arizona, in localities remote from the Missions, and under circumstances leading to the opinion that the furnaces, now obliterated, were erected and worked by the people who dug the irrigating canals,

and built the Casa Grande, in the valley of the Gila River, and lived in the ancient cliff dwellings.

LITHOGRAPHIC STONE—see Calcite.

89. LITHOMARGE. A fine grained hydrous silicate of alumina, probably sedimentary. It contains generally magnesia and lime. Specimen No. 423, in the State Museum, is from the Alpha Mine, Table Mountain, Tuolumne County; called "pipe clay;" No. 2515 is from near the Big Trees, Calaveras County; and No. 4498 from Lassen County.

LOADSTONE. Natural magnet—see Magnetite.

MACLE—see Andalusite.

MAGNESIAN LIMESTONE—see Dolomite.

90. MAGNESITE. Carbonate of magnesia. Magnesite is a valuable mineral, found in numerous localities in our State. None has, as yet, been put to practical use. The market has been generally supplied from Greece. It is exported to England to the extent of from one thousand to two thousand tons annually. It is sold for thirty-two drachms (about $5 44) per ton. It is used in England for the manufacture of sulphate of magnesia. A small quantity goes to Austria, and is used in the manufacture of hydraulic lime, and a smaller quantity to France, where it is used in the manufacture of firebrick and tiles. The California mineral will be turned to account at some future time, when it will be interesting and important to know where it may be found. The known localities in the State are as follows:

Alameda County. Mount Diable Range, thirty miles south of the mountain.

Mariposa County. A heavy bed of magnesian rock, chiefly magnesite, charged with crystals of iron pyrites, accompanies the chief gold-bearing quartz vein of this county. The rock is charged also with nickel and chrome talc in green films, like the magnesite of Canada.

Monterey County. On Arroyo Seco, in a vein two feet wide. The mineral contains also silica.

Napa County. Township nine north, range five west, M. D. M.

Placer County. At Gold Run and Damascus, said to exist in large quantities.

San Luis Obispo County. At Port Harford.

Santa Clara County. On Coyote Creek, about two miles from Madrone Station, Southern Pacific Railroad, a large deposit of excellent quality.

Tulare County. Near Visalia, below Four Creeks and Moore's Creek, in solid beds of pure white massive mineral. Hard, fine-grained like unglazed porcelain. The beds are from one to six feet thick, interstratified with serpentine and talcose slates. South side of Tule River, ten miles from Portersville.

Tuolumne County. Associated with gold-bearing quartz veins and serpentine.

An artificial carbonate of magnesia is obtained as a by-product in the tanks in working the mother liquors, from the manufacture of salt by the Union Pacific Salt Company, Alameda County, and largely used in the manufacture of explosives.

MAGNETIC PYRITES—see Pyrrhotite.

MAGNETIC SANDS—see Magnetite.

91. MAGNETITE. Magnetic iron ore.

Magnetite is a valuable ore of iron, and exists with other ores in numerous localities in California. The following are known localities:

Amador County. Two miles northeast of Jackson, magnetic sand, with pyrite; Sutter Creek.

Butte County. With native copper, in the Lincoln Tunnel; Ball Creek, near Oroville.

El Dorado County. Volcanoville (Blake); crystals in slate, near Boston Copper Mine, and with quartz and pyrite, Excelsior Copper Mine (Blake); two miles northwest of Shingle Springs; near Big Red Ravine, two miles from Coloma; Clarksville.

Fresno County.

Inyo County. Magnetite is found in a number of localities in the Inyo Mountains. Fine specimens of loadstone have lately been sent to the State Mining Bureau from the Slate Range, where it exists in quantity.

Los Angeles County. In the Cañada de las Uvas there is a vein, three feet thick, in limestone (Blake); also, thirty miles north of Los Angeles.

Mariposa County. East of the Mariposa estate (Blake); near Coulterville; base of Mount Hoffman.

Mendocino County. Six miles from Calpella.

Mono County. In a vein, five miles south of Benton, with steatite and gold (Aaron); Indian District. Analysis by Falkenau & Reese: Peroxide of iron, 93.00; silica, 7.00; total, 100.00; graphite and sulphide of copper, traces. Near Benton. Analysis by Falkenau & Reese: Peroxide of iron, 93.00; silica, 7.00; traces of sulphide of copper. This ore is said to be in very large quantities. Loadstone. Spur of White Mountains, half a mile south of Montgomery (Aaron).

Napa County. Near St. Helena.

Nevada County. Magnetic sands with gold and pyrite, concentration from hydraulic mines, Grass Valley.

Placer County. Utt's Ranch (Blake); near New England Mills; six miles from Auburn, large deposit; section fifteen, township thirteen north, range eight east.

Plumas County (after pyrite). Armentine Mine, with epidote and garnet (Blake); Mumford's Hill (Edman); near Gold Lake, line of Plumas and Sierra Counties; with hematite, near Crescent Mills.

San Benito County. Tres Pinos; Coast Range Mountains; fourteen miles from Hollister, in large quantities with limestone.

San Diego County. Eight or nine miles north of Mesquit Station.

Santa Barbara County (Trask).

Santa Cruz County. Near the town is an extensive bed; the needle deflected 31° on approaching it (Trask).

Shasta County. At Iron Mountain, five miles from the Sacramento River. Altitude above river, thirteen hundred feet. An abundance of wood at $2 50 per cord and plenty of water at the mine. Analysis by Kellogg, Hewston & Co.: Protoxide of iron, 11.58; sesquioxide of iron, 80.15; alumina, 1.69; silica, 4.95; water, 1.63. McCloud River; Potter's Iron Mine, seven miles from Shasta; in octahedral crystals, exact locality not known.

Sierra County. In large beds (Blake); Mohawk Valley, Sierra Iron Company.

Sonoma County. Mouth of Russian River; magnetic sands.

Trinity County. Near Weaverville (Trask).

Yuba County.

92. MALACHITE. Green carbonate of copper, mountain green. This mineral occurs with other ores of copper at numerous localities in the State.

Calaveras County. In remarkably fine specimens, with crystals of azurite, at Hughes' Mine (Blake); at Copperopolis.

Del Norte County. Low Divide.

Inyo County. At numerous localities in the Inyo and Coso Mountains.

Kern County. San Emidio Ranch, with melaconite.

Mono County. With azurite, cuprite, and partzite; Kerrick Mine, Blind Springs.

Plumas County. With azurite, gold, and quartz.

San Diego County. With azurite, cuprite, and chrysocolla; Lost Mine, thirty miles west of Colorado River.

San Luis Obispo County. Santa Rosa Creek.

Shasta County. Peck Mine, Copper Hill.

Tuolumne County. Whitman's Pass.

MALTHA—see Petroleum.

MANGANESE OXIDE—see Pyrolusite.

93. MARIPOSITE. This is a mineral of an apple green color, found with quartz, on the Mariposa estate, Mariposa County, and elsewhere on the great mother lode of the State. It has not yet been fully determined. It is referred by Dana to fuchsite. It was first described by Professor Silliman, December 2, 1867: see proceedings of the California Academy of Sciences, vol. 3, folio 380. It is represented in the State Museum by a single specimen, No. 1295, from the Josephine Mine, Mariposa County.

Quartz containing mariposite has been shipped to China from Mariposa County in considerable quantity, which mineral was the valued one is not known; as mariposite has a pleasing green color it has been thought that the Chinese either mistook it for jade or used it as a substitute.

MARBLE—see Calcite and special paper on Building Stones.

94. MARCASITE. Sulphide of iron, white pyrites. This mineral has the same composition as pyrites, but is of a white color. It is put to the same uses, such as making sulphur, sulphuric acid, etc. It is quite common as an associate of gold in California with pyrite (yellow colored), chalcopyrite, galena, sphalerite, mispickel, etc.

95. MELACONITE. Black oxide of copper. This is a rare mineral in California. It is said to occur with malachite at the San Emidio Ranch, Kern County, and in the Afterthought Mine, Shasta County. Melaconite occurs in the Satellite Copper Mine, formerly the Lancha Plana, near Campo Seco, Calaveras County, in masses of considerable size, with bornite, and containing granules of metallic copper the size of bird-shot. In the R. F., with chloride of ammonia it imparts an intense blue color to the flame. It is partly soluble in hydrochoric acid. The mineral occurs in nodules, black and earthy inside, but covered with a white incrustation.

96. MENACCANITE. Ilmenite, titaniferous iron. A single but fine crystal was found in the gold washings near Georgetown, El Dorado County. It was about an inch in diameter, with brilliant planes (Blake). Fine specimens are brought from Bill Taylor's Ranch, near Buchanan, Fresno County, twenty miles southeast of Mariposa.

97. MERCURY. Native mercury is found in many of the quicksilver mines in the State, but never in large quantities. It always occurs near

the surface of the earth, above active mines in which cinnabar has formed and is still forming. Sometimes a soft rock overlying the mines, the nature of which has not been properly studied, on being broken open is found to be permeated by native mercury in minute globules. Under the head of cinnabar the production of quicksilver in the State is given.

98. METACINNABARITE. This rare mineral is a black sulphide of mercury, described by G. E. Moore in 1870. It resembles cinnabar in composition, being like that species (Hg S), but differs from it in color, streak, specific gravity, and luster. It corresponds to the black sulphide of mercury, produced artificially by mixing the elements; while cinnabar conforms to the artificial sulphide obtained by sublimation. It occurs with cinnabar and native mercury in several quicksilver mines in California, and has lately been found in Oregon. It has never been obtained in large quantities like cinnabar, and is still considered a rare mineral. When first found it was generally thought to be amorphous, but it has since been found beautifully crystallized in the Redington Mine, Napa County, the locality where it was first discovered. Fine specimens have been obtained in the Great Western Mine, Lake County; in the California Mine, Yolo County, amorphous and in crystals.

99. METEORIC IRON. In 1866 Dr. Trask found a small fragment of iron in Honcut Creek, Butte County. It had the appearance of cast-iron, and was pronounced by Professor Brush not to be meteoric. Still it was considered remarkable at the time, that a fragment of cast-iron should have been found under the circumstances, and it is a little singular that a similar fragment has been recently sent to the State Mining Bureau, which was found on the bedrock, near Columbia, Tuolumne County. At a meeting of the California Academy of Sciences, February 19, 1866, Professor J. D. Whitney stated that Dr. J. G. Coffin had found fragments of iron in the bed of the Mohave River. At that time no meteorite had been found in California that was known to be such.

There was a rumor, a number of years ago, that there was a large mass of meteoric iron on the line of travel up the coast, a few miles north of Crescent City, Del Norte County, but it could never be traced to any reliable source. The El Dorado meteorite was found at Shingle Springs, by a blacksmith whose name is not given. It was noticed by J. H. Crossman in 1871, and placed in the cabinet of W. V. H. Cronise, where it was seen and described by Professor B. Silliman, in the *American Journal of Science and Arts* for July 18, 1873, with a figure from a photograph by Watkins of San Francisco. A short notice of it by Professor C. U. Shepard of Amherst College, appeared in the same journal of June, 1872. The weight of this meteorite was about eighty-five pounds avoirdupois. Its largest dimensions were twenty-four and twenty-nine centimeters; density, 7.875. No Widmannstattian figures were developed by etching.

The following analysis of it by J. A. Cairns, of the School of Mines, Columbia College, New York, is published:

Iron	81.480
Nickel	17.173
Cobalt	.604
	99.257

With the following elements in small proportions: aluminum, calcium, carbon, chromium, magnesium, phosphorus, potassium, sulphur.

Professor Shepard arrived at quite different results, viz.:

Iron	88.02
Nickel	8.88
Insoluble	3.50
	100.40

This meteorite still remains in San Francisco.

The *San Bernardino Meteorite*, No. 2339, State Museum, was found in 1880 in the Ivanpah Mining District, San Bernardino County, by Stephen Goddard. The weight, before cutting, was 1,870 troy ounces. Dimensions: length, 13.5 inches; width, 9.7 inches; thickness, 8 inches. Specific gravity of the mass, 7.693. It is an irregular body or mass of malleable iron. The surface is covered with concave cup-like depressions, some of which have considerable depth. The fine Widmannstattian figures on the cut face were developed by the action of nitric acid, and the smooth rim or border was protected from the action of the acid by wax, and should not be mistaken for a crust or outer shell. On one end of the aerolite may be seen distinct crystals corresponding to those developed by acid. Photographs, on a scale of one third the actual size, were taken of this specimen, both before and after cutting. Lithographs from these photographs were published in the fourth annual report. The following analysis was made in the University of California by Mr. Gustav Gehring:

University of California, Berkeley, May 17, 1884.

Analysis of the San Bernardino Meteorite, by Gustav Gehring, Assistant in Chemistry in the University of California:

Iron	94.856
Nickel	4.469
Cobalt	.261
Silica	.041
Sulphur	.004
Phosphorus	.002
Carbon in combination	.115
Graphite	.067
	99.815

Hardness, 3.75; specific gravity, 8.076.

100. MICA. Isinglass, muscovy glass, etc. See also biotite. Muscovite is abundant in the granite rocks of the State.

The following include the principal localities at which this mineral has been found in California: At Gold Lake, Plumas County; in El Dorado County; Ivanpah District, San Bernardino County; near Susanville, Lassen County; and at Tehachapi Pass, Kern County; it having been observed at many other places in the State. As little or no work has been done on any of these deposits, not much can be said in regard to their probable value, one way or the other. We have reports of mica being found in nearly all the Pacific States and Territories; also in those contiguous to the Rocky Mountains; its occurrence in some of these being abundant, and extending to many different localities.

Micaceous Iron—see Hematite.

101. MILLERITE. Sulphide of nickel. This mineral is brass-yellow, resembling chalcopyrite. It is not a common or abundant mineral, and in California has been observed only at one locality, half a mile from Cisco, Placer County.

Mineral Coal—see Lignite.

MINERAL WATERS—see special paper on this subject elsewhere.
MISPICKEL—see Arsenopyrite.

102. MOLYBDENITE. Sulphide of molybdenum.

This is a soft, black, lustrous, foliated mineral, resembling graphite, for which it is frequently mistaken. It has no special value. It is rather common in California, in the granites of the Sierra Nevada, and associated with gold in the quartz veins, and frequently with copper and silver ores.

The following are the most important localities in the State. Most of them are represented in the State Museum:

El Dorado County. Cosumnes Copper Mine, with ores of copper.

Fresno County. Speckerman's Mine, Fresno Flat.

Inyo County. Beveridge Mine; foliated; mistaken for graphite; near Independence.

Nevada County. Excelsior Mine (Dana).

San Diego County. At Campo.

Tulare County. South Fork of King's River, forty-five miles northeast of Visalia.

103. MOLYBDITE. Molybdic acid, molybdic ochre, molybdine.

According to Dana, this mineral is found in the Excelsior Mine, Nevada County, with molybdenite and gold.

MOUNTAIN BLUE—see Azurite.
MOUNTAIN BUTTER—see Lenzinite.
MOUNTAIN CORK—see Amphibole.
MOUNTAIN LEATHER—see Amphibole.
MUNDIC—see Pyrite.
MUSCOVITE—see Mica.
NATRON—see Trona.

104. NICKEL ORES. See also Millerite and Zaratite.

Dr. Trask, in his first "Report on the Geology of the Coast Mountains, and part of the Sierra Nevada, 1854," refers to nickel ores, "in the Coast Mountains from Contra Costa to the utmost limit reached in that range, associated with chromic iron in primitive rocks. The mineral is more abundant in the serpentine rocks south of Tularcitos, and near San Antonio, Monterey County." This mineral, zaratite, or "emerald nickel," will be described under the proper head.

NITRATE OF SODA—see Soda Niter.
OBSIDIAN—see Orthoclase.
OCHRE—see Limonite.
ONYX MARBLE—see Aragonite.

105. OPAL. Hyalite, wood opal.

Only the inferior varieties of opal are known in California, and these only at a few localities, as follows:

Alameda County. With semi-opal in Mount Diablo Range, thirty miles south of the mountain (Blake).

Amador County. At Volcano (Hyalite).

Calaveras County. A white milky variety of opal is found in Calaveras County, at Mokelumne Hill, or on the hill near that place known as Stockton Hill, on the west side of Chile Gulch. A shaft has been sunk there three hundred and forty-five feet, and the opals are found in a thin stratum of red gravel. They vary in size from a kernel of corn to the size of walnuts. Many of them contain dendritic infiltrations of manganese

oxide, looking like moss. About a bushel of these stones are raised in one day, and are said to have a market value. A white, milky variety similar to the above, and without "fire," is found with magnesite in the Mount Diablo Range, thirty miles south of the mountain. Also in the foothills of the Sierra Nevada, at the Four Creeks (Blake).

This locality is represented in the State Museum by No. 4395. They are also found near Murphy's, Calaveras County (Dana).

El Dorado County. Nine miles northeast of Georgetown.

Lake County. Kelseyville—hyalites found plentifully in cavities in basaltic lava, township ten north, and ranges five and six east.

San Bernardino County. (Hyalite). Hyalite resembles glass, and is generally found in irregular fragments. Opalized wood is wood petrified and changed to opal. It is not uncommon in the hydraulic gold mines, in magnificent specimens.

Osmium—see Iridium, with which it is invariably alloyed or associated.

Opalized Wood—see Opal.

106. ORTHOCLASE. Feldspar, common feldspar, potash feldspar, obsidian.

Orthoclase, and obsidian, a variety of the same mineral, are found in numerous localities in California.

Fresno County. (*Orthoclase*), near Millerton, in coarse granite.

Inyo County. (*Obsidian*), with basaltic lava.

Kern County. (*Orthoclase*), in veins several feet thick, Tehachapi Pass.

Lake County. (*Obsidian*). When first discovered, years ago, at Clear Lake, in Lake County, a company was formed to make bottles and other glassware from it, but the enterprise was of course a failure.

Near Lower Lake, in fine specimens—black, gray, red, and variegated.

Lassen County. (*Obsidian*), found in great abundance on the east side of Eagle Lake, a mile, more or less, from Clark's Ranch. It is found scattered over the surface and in the soil with a porous, redish colored lava.

Mariposa County. (*Orthoclase*), in veins in granite, with molybdenite, in Yosemite Valley.

Modoc County. (*Obsidian*), south end of Goose Lake.

Mono County. (*Obsidian*), McBride's Ranch, near Mono Lake, in and at the base of volcanic cones.

Napa County. (*Obsidian*), three miles west of Napa.

Plumas County. (*Orthoclase*), at Meadow Valley.

San Diego County. (*Orthoclase*), Hunsacker Grade, stage road from San Diego to Julian, in considerable quantities and suitable quality for the manufacture of fine pottery. It is associated with pegmatite, also useful for the same purpose; near the Owens Mine, Julian, in coarse granite. Some varieties of obsidian cut beautifully, and might be used for ornamental purposes, for paper weights, vases, bases of clocks, and similar purposes.

Osmium—see Iridium, with which it is invariably alloyed or associated.

Pandermite—see Priceite.

Partzite—see Stibiconite.

Pearl Spar—see Dolomite.

107. PECTOLITE. A single specimen was found in a bowlder or fragment at the foot of the White Mountains, near Montgomery, Mono County. Doubtful (Aaron).

108. PETROLEUM.

Under this heading also *asphaltum*, *maltha*, *brea*, *idrialite*, *bitumen*, *aragotite*.

For special paper on this subject see fourth annual report, folio 278.

Petroleum has been found in the following counties in this State, viz.: Alameda, Colusa, Contra Costa, Humboldt, Kern, Lake, Los Angeles, Mendocino, Napa, San Bernardino, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Sonoma, Tulare, and Ventura.

The most important localities are given below; for details of the occurrence see fourth annual report.

PETROLEUM—

Alameda County. Near Midway.

Los Angeles County. In Pico Cañon, near Newhall, where there are numerous wells which yield very large quantities; at Puenta; at Petrolia, near the latter, on section five, township three south, range nine west, since my visit in May, 1884, flowing wells have been struck. In October, 1885, in sinking a well in Cahuenga Valley, a flow of petroleum was struck, which according to the Los Angeles *Evening Express*, it was impossible to check.

San Mateo County. At Tunitas Creek, several wells which have produced excellent light oil.

Santa Barbara County. Oil springs under the ocean; oil seen floating on the surface of the sea; these oil springs have been described elsewhere in this report.

Santa Clara County. At Moody Gulch—extensive works—considerable high grade oil produced.

Ventura County. At Santa Paula, where large receiving tanks have been provided.

ASPHALTUM AND MALTHA—

Kern County. Near Buena Vista Lake and elsewhere, in large quantities.

Los Angeles County. La Bréa Ranch, near Los Angeles.

San Luis Obispo County. Coral de Piedra.

Santa Barbara County. Goleta Landing, seven miles west of the town of Santa Barbara, on Laguna Santos and Los Alamos Ranchos, near Carpenteria.

Santa Clara County. Sargent's Ranch, in large quantities.

Ventura County. Oil wells near Sulphur Mountain, Santa Ynez, and Kayamos Valleys, near Mission of San Buenaventura.

ARAGOTITE—

This mineral, a hydro-carbon, was found by F. E. Durand, in the New Almaden Quicksilver Mine, and, so far as known, is peculiar to the quicksilver mines of this State.

109. PETZITE. This mineral is a telluride of silver and gold. It is of too rare occurrence in California to have any practical value aside from the gold it contains, and interesting only as being an associate of gold.

An analysis of a specimen from the Stanislaus Mine, Calaveras County, afforded Kustel:

Tellurium	35.40
Silver	40.60
Gold	24.80
	100.80

While this analysis shows the mineral to be rich in gold, it is so rare that only very small specimens can be obtained, and these but seldom. It

occurs with the other tellurium minerals which constitute but a very small portion of the vein matter.

The following localities are known: Stanislaus and Melones Mines, in Calaveras County; Morgan Mine, Tuolumne County.

110. PHOSGENITE. Chloro-Carbonate of Lead.

A single specimen has been found in quartz from the Silver Sprout Mine, western slope of the Sierra Nevada, Inyo County. Straw-colored, acicular interlaced crystals in cavities (Aaron). Determination by C. Ide.

PHOSPHATE OF LIME—see Apatite.

111. PICOTITE. Chrome spinel.

Has been found by Dr. M. E. Wadsworth in the basalts of Mount Shasta; "Summary of the Progress of Mineralogy in 1882," H. C. Lewis.

PICROLITE—See Serpentine.

PLATINIRIDIUM—See Platinum and Iridium.

112. PLATINUM—See, also, Iridium.

Platinum is rather abundant in California with other metals of the group. The miners call it "white gold," and generally believe it to be more valuable than that metal, generally declining to save it when informed that it can only be sold for two or three dollars per ounce.

The following are the most important localities:

Butte County. Platinum minerals are rather abundant in this county. Considerable quantities are recovered in the clean-ups at the Spring Valley hydraulic mine. At St. Clare Flat near Pence, large quantities were found in the early days of placer mining.

Mendocino County. With iridium, cinnabar, zircons, and gold, Anderson Valley, on the Navarro River.

Plumas County. Mr. A. Hewett found several large pieces of platinum in 1851 on Nelson Creek. The largest was the size of a large bean. It is found also at Gopher and Badger Hills.

Trinity County. Found with iridium and associated metals and minerals, and in considerable quantities, at Hay Fork, a large stream. All the gold found is more or less mixed with the platinum metals; so much so that dealers deduct two dollars per ounce from the price paid elsewhere for gold dust. At North Fork of Trinity River, platinum is found in less quantities, but in larger pieces. One was once offered for sale in Marysville which weighed over two and a half ounces troy.

Although platinum occurs in the river beds, and on the banks of the streams, yet in the so called "hill claims," about half a mile only from the river, no trace of that metal has been found. In lower Trinity, near its junction with the Klamath, platinum abounds in very fine particles; and it is with this finely divided platinum that Professor Wöhler discovered diamonds.

The metal is so abundant that the miners have the utmost difficulty in separating it from the gold. The particles are so extremely fine that they can hardly be distinguished from the black sand which accompanies the gold. Heretofore no effort has been made to place the platinum in the market, except the sending to San Francisco of one hundred ounces or more, a few years ago. It could, probably, be sent to Europe to advantage. In Salmon River it is also found. In fact, it is common in the beds of the streams in Sierra, Trinity, Klamath, and Del Norte Counties.

Mr. Block of San Francisco, said that large pieces have been found on North Fork of Trinity River; one piece weighed two ounces. The miners

in washing gold in long sluices got the gold by the aid of quicksilver, and the platinum minerals remained in the riffles; with platin-iridium, in a claim three miles from Trinity Center; and with gold zircons, diamonds, and other minerals on the ocean beach, from Cape Blanco to Cape Mendocino.

Dr. S. R. Hayden, now of Chicago, was at Rich Bar, North Feather River, in 1851. He found in a placer mine he was working a piece of white metal, very heavy, about three inches long, two inches wide, and about half an inch thick, which he thinks must have been platinum.

113. POLYBASITE. A sulphide of many bases, viz.: antimony, arsenic, copper, iron, silver, and zinc.

It is a rare mineral in California, being found only in small microscopical crystals in the Morning Star and Monitor Mines, Alpine County.

114. PRICEITE. Borate of lime, pandermite, colemanite, etc.

The variety pandermite has recently been found in apparent abundance in Death Valley, Inyo County, and at Calico, San Bernardino County, and the cryptomorphic variety also at the latter locality.

Colemanite—

Is also a variety of priceite found recently in Death Valley in a crystalline state. As this mineral possesses certain physical properties differing from priceite, a name has been given to it to distinguish it from the soft chalky mineral found both in southern Oregon and San Bernardino County, California.

The name *colemanite* was given by the discoverer of the mineral in honor of William T. Coleman of San Francisco, who has been identified with the borax interests of the Pacific Coast from the commencement. Colemanite is now found in magnificent crystals, but good crystallized specimens are very scarce.

115. PROUSTITE. Light ruby silver ore.

Arsenical sulphide of silver, found sparingly in the Chicago Mine, Shasta County, with galena, pyrite, and quartz, between walls of granite (Aaron). No. 4951, in the State Museum, from the Oro Mine, Bodie, Mono County, shows it in crystals, with pyrargyrite in quartz.

116. PSILOMELANE. A hard black mineral, supposed to be psilomelane, is found in several localities in the State, with pyrolusite and rhodonite, but no analysis has been made to prove it. This mineral differs from pyrolusite in containing baryta and oxide of manganese, and more water. It has been found at Spanish Ranch, Plumas County, on Red Rock, Bay of San Francisco, and in quartz, Santa Ana River, Los Angeles County.

Pumice Stone—see Orthoclase.

117. PYRARGYRITE. Dark ruby silver, antimonial sulphide of silver.

This mineral, like proustite, is rare in California. It has been found in the Exchequer Mine, Alpine County, and with proustite, in the Oro Mine, Bodie, Mono County.

118. PYRRHOTITE. Magnetic pyrites.

Found in Mariposa County, at the Iona Copper Company's tunnel, north side of the Merced River, on the trail from Bear Valley to Coulterville (Blake).

119. PYROLUSITE. Binoxide of manganese.

The known California localities are:

Alameda County.

Calaveras County. Near Angels'; Railroad Flat.

Colusa County. About two miles south of Font's Springs, township seventeen north, range seven west.

Contra Costa County. Corral Hollow—abundant.

Marin County. Near Saucelito and Tomales.

Napa County. St. Helena Mountain.

Nevada County. Sweetland.

Plumas County. Argentine, and Mumford's Hill (Edman).

San Bernardino County. With rhodonite, near Colton.

San Francisco Bay. Red Rock, San Francisco County; Bernal Heights, San Francisco; just south of St. Mary's College, Peninsula of San Francisco.

Santa Clara County. Hahn's ranch, twelve miles south of the Guadalupe Quicksilver Mine.

Sonoma County. Near Cloverdale; Santa Rosa.

Tuolumne County. Knight's Ranch, near Columbia, in botryoidal and mammillary masses, from the size of a grape to one hundred pounds in weight, on the surface of the ground; with rhodonite, two miles south of Summerville.

120. PYRITES. Pyrite, sulphuret of iron, the "sulphurets" of the gold miner, mundic, martial pyrites. See, also, Marcasite.

Of the numerous localities of pyrite in the State, the following are worthy of special mention, or are represented in the State Museum:

Alpine County. Morning Star Mine, with enargite.

Amador County. Jackson.

Calaveras County. E Pluribus Unum Mine, three miles from Murphy's (Blake).

El Dorado County. Brilliant cubes, Mameluke Mine, near Georgetown (Blake); Pilot Hill, in large cubes, with garnet-brown spar and specular iron (Blake); in crystals with gold, with quartz, both crystallized.

Inyo County. Modoc Mine.

Mariposa County. In slates, in large and perfect crystals, near Princeton Hill (Blake).

Mono County.

Napa County. With cinnabar, Redington Quicksilver Mine, very fine; in cavities in quartz, cubical crystals, Knox & Osborn Quicksilver Mine.

Nevada County. Grass Valley, massive, with chalcopyrite, San Francisco copper mine, Spenceville; massive, with gold, Meadow Lake District; taking the form of wood, with hematite, Occidental Mine, Scott's Flat; with calcite, Malakoff Mine, North Bloomfield; in lignite, Malakoff Mine, North Bloomfield.

Placer County. Globular, in calcite, near Auburn; Clipper Coal Mine, near Grizzly Bear House, Forest Hill, in large crystals (Blake); True Fissure Mine, Devil's Peak Mountain; with lignite, Spinks' Coal Mine, Lincoln.

Plumas County. Granite Basin, Mumford's Hill, in crystals, with dolomite (Edman).

San Luis Obispo County. In cavities in the Sunderland Quicksilver Mine.

Shasta County. With pyrolusite and gold, Banghart Mine; with erube-

scite and chalcopyrite, Copper City; in nodules, with sulphide of silver, very rich.

Tuolumne County. In fine crystals, Patterson Mine, Tuttletown.

121. PYROPHYLLITE. This mineral, a hydrous silicate having no economic value, but which is interesting from a scientific standpoint, is found in beautiful radiating tufts of a golden yellow color, at Greaser Gulch, or Indian Gulch, Mariposa County. It occurs in large bowlders on the surface of the ground near two prominent buttes. This locality is represented by No. 3723 in the State Museum.

122. PYROXENE. A silicate of different bases, the varieties of which are known under different names, as augite, diopside, sahlite, omphazite, hypersthene, diallage, smaragdite, etc.

This mineral enters largely into the composition of igneous rocks. In this form it is probably largely distributed in California. It is found in fine dark green crystals near Mud Springs, El Dorado County (Blake), and also in fine crystals at the Cosumnes Copper Mine, in the same county.

123. QUARTZ. The varieties are known by many names, among which are agate, amethyst, aventurine, blood stone, Brazilian pebble, buhr stone, carnelian, cat's-eye, chalcedony, chrysoprase, cairngorm, false topaz, heliotrope, jasper, mocha stone, onyx, prase, quartz and quartzite, rock crystal, siderite, silicified wood, sardonyx, etc.

Quartz is very abundant in California. It forms the principal vein matter in the gold mines, associated with blende, galena, chalcopyrite, freibergite, bornite, mispickel, pyrite azurite, and malachite, scheelite calcite, caproscheelite, dolomite, enargite, and other minerals. It would be impossible and unnecessary to enumerate all the known localities in the State. The following are the most important and interesting. The massive quartz found almost universally where the rocks are not covered with soil, is not included:

Alameda County. Hills back of Berkeley, *chalcedony.*

Alpine County. Monitor, *red jasper.* Sonora Trail, *chalcedony.* Morning Star Mine, *quartz.* Hope Valley, *rose quartz*, massive, very fine; *drusy crystals.*

Amador County. Near Volcano, *chalcedony, silicified wood.* Ione Valley, *diatomaceous earth.*

Butte County. North Fork of Feather River, *smoky.* Near Doon's Mill, *crystals*, fine, and *chalcedonic pebbles.* Three miles south of Cherokee Flat, Gold King Mine, with quartz, *sacchroidal quartz*, like that in the gold mines of Georgia and Brazil.

Calaveras County. Mokelumne Hill, *silicified wood.* In the gold mines, croppings, or "iron hat," *red jasper.* Murphy's, *brown jasper*, which polishes beautifully; *cat's eye.* Vallecito, *chalcedony.* Chili Gulch, Duryea's Hydraulic Mine, *silicified wood.* Near Comanche, *diatomaceous earth.* Murphy's, *chalcedony.* Near Angel's Camp, *silicified wood.* Dutch Flat, in hydraulic mines, *silicified wood*, very fine. Roseville, *silicified wood.*

Contra Costa County. Mount Diablo Coal Mine, with lignite, *silicified wood.*

Del Norte County. Crescent City beach; *chalcedony, jasper, carnelian, agate.*

El Dorado County. Summerfield, Mosquito Cañon, near Placerville; *cairngorm, rock crystal, smoky quartz* in crystals six inches in diameter (Blake).

Fresno County. Fresno Flat, *yellow granular quartz* containing gold, resembling that found in the gold mines of Georgia. The gold is remarkably fine.

Inyo County. Eclipse Mine, *chalcedony;* very fine. Beveridge District, *double terminated crystals, smoky quartz.* Modoc Mine, in beautiful forms. Panamint, colored with malachite. Wyoming Mine, in fine large clusters of crystals; very fine. Small Butte, in Owens Valley, *buhrstone;* good quality.

Lake County. Eclipse Mine, seven miles west of Lower Lake, *silicified wood.* Lost Spring Ranch, *diatomaceous earth.*

Los Angeles County. Between Williamson's Pass and Johnson's River, *chalcedony* in pear-shaped nodules in eruptive rocks (Blake). Santa Monica, *diatomaceous earth.* Fourteen miles south of San Pedro, *diatomaceous earth.*

Marin County. Saucelito, *jasper;* red and green.

Mariposa County. Merced River, between Horse Bend and Don Pedro Bar, *oil stone*, or novaculite, discovered in 1866, and said to be of good quality. Pine Tree Mine, *hacked quartz;* a peculiar variety of quartz which has a resinous luster and containing mariposite, has been shipped to China, said to be used in the manufacture of porcelain. There were four shipments of three to four tons each.

Modoc County. Jess Valley, *bloodstone.* Pit River, near Goose Lake, *buhrstone* in great abundance (Trask).

Mono County. Mono Lake, *silicified wood.* Bodie Mines, on silver ore in fine crystals, *chalcedony*, pink and straw colored, very fine; *hornstone.*

Monterey County. Monterey, on the beach; quartz sand, much employed for glass-making and other purposes; near Panoche's, large masses of *chalcedony*; white and delicately veined; in mammillary sheets; *diatomaceous earth* in numerous localities.

Napa County. Manhattan Mine, with cinnabar and stibnite, *chalcedony*; Mount St. Helena, *silicified wood*; near Calistoga, *silicified wood*; near St. Helena, *jasper, chalcedony.*

Nevada County. In the gold mines; often supporting native gold between the crystals (Blake); Hinchman's hydraulic mine, *quartz breccia*; Malakoff Mine, *quartzite*; Omega, *silicified wood*; Chalk Bluffs, *silicified wood* in many varieties in the hydraulic mines.

Placer County. At Lincoln, in beds several feet in thickness, *quartz sand*, very pure and white. *Silicified wood* at a number of localities. Dutch Flat, *diatomaceous earth.* Forest Hill, *silicified wood.* Gold Run, *silicified wood.* Shores of Lake Tahoe, *carnelian, agate.*

Plumas County. *Rose quartz*, fine. Claremont's Hill and Mumford's Hill, *jasper.* Long Valley and Spanish Creek, *agate.* Granite Basin, *quartz crystals*, very fine.

San Bernardino County. Soledad Cañon, *chalcedony.*

San Diego County. Seacoast, forty miles north of San Diego, *diatomaceous earth.* Big Tank, Colorado Desert, *silicified wood, chalcedony.*

San Francisco County. *Jasper*, red and green. On the seabeach, *quartz sand* with magnetite.

San Joaquin County. Staples' ranch and San Carlos ranch, *diatomaceous earth.*

San Luis Obispo County. *Agate, silicified wood.* Port Harford, *diatomaceous earth.*

San Mateo County. *Chalcedony, jasper;* Pescadero beach, *carnelian, agate, chalcedony;* San Gregorio, *diatomaceous earth.*

Santa Barbara County. *Diatomaceous earth.*

Santa Cruz County. Ranch of Harry Love, near San Lorenzo, there is said to be a mountain of *white quartz sand.*

Shasta County. Hacked quartz with gold.

Sierra County. Near Downieville, *silicified wood.*

Sonoma County. Ten miles north of Petaluma, *diatomaceous earth;* Santa Rosa, *silicified wood*; before petrefaction the wood had been pierced by worms; near Windsor, *bloodstone;* eighteen miles southeast of Santa Rosa, *diatomaceous earth.*

Tulare County. Portersville, *silicified wood;* Yokhe Valley, *rose quartz.*

Tuolumne County. Columbia, *silicified wood;* Douglasville, *chalcedony.*

QUARTZITE—see Quartz.

QUICKSILVER—see Mercury.

124. REALGAR. Sulphide of arsenic. This mineral is rare in California, being known only with arsenolite in Alpine County.

RED OXIDE OF COPPER—see Cuprite.

RED OXIDE OF IRON—see Hematite.

125. RESIN. Fossil.

In the hydraulic gold mines of California a fossil resin is frequently met with, which is probably from the coniferous trees of former growth, found in such profusion in a silicified state. It is brittle and resinous, and still retains an odor. It somewhat resembles gum dammar, but is more yellow. It has never been studied.

RETINALITE—see Serpentine.

126. RHODONITE. Silicate of manganese.

It occurs in several localities in the State, always with pyrolusite; with native copper, Mumford's Hill; Plumas County (Edman); one mile from the Southern Pacific Railroad, between Colton and San Diego; near San José, Santa Clara County; two miles south of Summersville, Tuolumne County, in considerable quantity; a large deposit of rhodonite and pyrolusite occurs two miles north of Sonora, Tuolumne County. Rhodonite has little or no economic value.

127. ROCK SOAP. This is a mineral resembling halloysite and mordenite, but believed to be a mechanical mixture of two or more minerals. It has the remarkable property of removing impurity from the skin, like soap, whence the name. There have been numerous analyses made which do not agree among themselves. A paper was published by Professor George H. Koenig, in *The Naturalists' Leisure Hours*, Philadelphia, which is very full and explicit, giving the result of considerable laboratory work. A series of analyses were made in the laboratory of the State University, which have not been published. In Professor Koenig's examination the soapy portion was separated mechanically from a sandy portion and analyzed, with the following results:

Sesquioxides of alumina and iron	14.10
Silica	73.10
Water	6.70
Not determined	6.10
	100.00

Nearly all the silica was found to be in the soluble or opaline state, and the alumina either as a hydrate, or a very basic hydrated silicate. At one time this material was manufactured into a variety of useful articles, as

salt water soap (it having been found that the presence of salt and lime did not impair its detergent properties), scrubbing, and toilet soap, and even tooth powder. Having had occasion to examine into the merits of these preparations, I am prepared to say that they served every purpose claimed for them. At the Paris Exposition of 1878, samples were shown which attracted considerable attention, and there were those who expressed an inclination to enter into their manufacture in France. At present "rock soap" is largely used in the manufacture of certain kinds of soap in California. No. 4024, in the State Museum, is a specimen from Ventura County, and No. 4794 is from San Benito County.

128. ROSCOELITE. Vanadium mica. This very rare mineral was described in the second annual report, folio 262, and a history given of its discovery.

California known localities:

The "Stuckslager," "Plum Tree," or "Sam Simms" Mine lies in section twenty-four, township eleven north, and range nine east, Mount Diablo base and meridian, somewhat more than a mile from the town of Coloma, in a southwest direction, where it was first found.

Another locality of roscoelite in the State, is section thirty-one, township eleven north, and range ten east, two miles from the Sam Simms Mine. Big Red Ravine is on this section, lying only two miles from the site of Sutter's Mill, where gold was first discovered. It was one of the earliest placer mines known in the State, and so rich did it prove, that it has paid to rework as many as seven times. It is in the bedrock of these old workings that roscoelite is found.

Recently a fine specimen of roscoelite has been presented to the State Museum, which is mixed with gold to the extent of seemingly half the bulk of the specimen. It was presented by Richard Sparling and is numbered (5768). It is from the Tip Top vein, section seven, township eleven north, range ten east, El Dorado County. There is about a foot of quartz disseminated through the vein, in small bunches, connected with which are seams of roscoelite, generally very thin, from the thickness of paper to half an inch. Occasionally a bunch of roscoelite appears, from which specimens like No. 5768 may be obtained, but these are extremely rare. Mr. Sparling says that at the Sam Simms Mine, the owners once took out of a pocket $11,000. A great deal of free gold has been washed from the sides of the hill, below the vein, which came, without much doubt, from decomposed roscoelite, and it is more than probable that the gold discovered at Sutter's Mill, in 1848, and that taken from Big Red Ravine, were from the same source. In the Tip Top there is a sheet of what seems to be sandstone; when this and the brown slate come in contact, gold and roscoelite are found.

RUBELLITE—see Tourmaline.

RUBY SILVER—see Pyargyrite and Proustite.

129. RUTILE. Titanic acid. Is found at Long Valley, Plumas County (Edman); and frequently in acicular or capillary crystals in quartz. No. 3747 is a specimen of this character from Humboldt County, Nevada, and there are other specimens in the museum from other localities. Titanic acid has few applications in the arts; it is used in porcelain painting, and to give color to artificial teeth.

SALT—see Halite.

130. SASSOLITE. Native boracic acid.

Boracic acid, free or combined, is a common occurrence on the Pacific Coast. It has been detected in the waters of the ocean along the shores of California and Oregon. Common salt, made by evaporating the sea-water, contains more than traces of boracic acid. According to Professor W. P. Blake, it occurs in a free state in the water of Clear Lake. The discovery of this acid in mineral water in Tehama County led to the examination of other springs then known, which resulted in the finding of boracic acid in nearly all of them. It was found later in the mud volcanoes in San Diego County by Dr. Veatch, which was verified by my own observation.

SATIN SPAR—see Gypsum.

131. SCHEELITE. See also Cuproscheelite, tungstate of lime.

Only one locality is known in the State, the footwall of a gold mine on Howard Hill, Grass Valley, Nevada County, where it is said to occur in considerable quantity.

SCHORL—see Tourmaline.

SELENITE—see Gypsum.

SEMI-OPAL—see Quartz and Opal.

132. SEPIOLITE. Meerschaum, hydrous silicate of magnesia.

A specimen in the State Museum from the Half Dollar Mine, Inyo County, resembles sepiolite, but as yet no analysis has been made to determine it.

133. SERPENTINE. Chrysotile, picrolite, retinalite. This mineral is very abundant in California. Quicksilver and chromium ores are found in it almost universally. The following localities are represented in the State Museum:

Butte County. Near Red Hill. The bedrocks are serpentine; fine specimens of picrolite are found.

Lake County. Kelseyville.

Marin County. Very abundant.

Mariposa County. Three hundred yards northeast of the Pine Tree Mine, and elsewhere in the county.

Mendocino County. Township ten north, range ten west, foliated serpentine and picrolite found in considerable quantity.

Monterey County. Coral de Tierra.

Napa County.

Nevada Coanty. Grass Valley, in the Maryland Mine, picrolite.

Placer County. Bald Prairie; Verde antique or ophite, serpentine with carbonate of lime, has recently been found near Yankee Jim's. It is of a sea-green shade, with blotches of a darker color. It is a beautiful ornamental stone, if it can be found in sufficient quantity. The specimen sent to San Francisco was small.

Plumas County. Claremont Hill, Meadow Valley, retinalite, green and translucent.

San Francisco County. Peninsula of San Francisco, Fort Point, with aragonite; in the streets of San Francisco, Market Street Cut, and the cemeteries.

Santa Barbara County. Goleta.

Santa Clara County. New Almaden Mine, schistose, and in many other quicksilver mines in the State; Gilroy.

Shasta County. McCloud River, with *chrysotile.*

Sonoma County.

Tehama County. Township twenty-five north, range seven west, with chromic iron in large quantities.

Yuba County.

134. SIDERITE. Spathic iron, carbonate of iron.

This mineral has recently been found by J. W. Redway in quartz ledges in Tejunga Cañon, Los Angeles County, and is represented in the State Museum by No. 3712.

SILICIFIED WOOD—See Quartz.

SILICATE OF COPPER—See Chrysocolla.

135. SILVER. While silver minerals are abundant in California, native or free silver is of rare occurrence; it is even then found only in specks or very thin sheets, covering but small surface. This is the case in Mono County in the Diana, Kerrick, and Comanche Silver Mines, where it is sometimes seen on partzite, and in the Tower Mine, near Benton. It occurs, also, in the silver ores in Inyo County, notably in the Kearsarge District, in the form of electrum (gold alloyed with silver or the reverse). It is found, also, in Bodie, in Mono County, and in Fresno County, near Millerton.

SILVER GLANCE—see Argentite.

SLATE—see Building Stones.

136. SMITHSONITE. Carbonate of zinc. Said to occur with cerusite in the Modoc Mine, Inyo County.

137. SODA NITER. This important mineral is nitrate of soda. Found only in small quantities in caves and cavities in the rocks near Calico, San Bernardino County. It is reasonable to expect from the nature of the climate that it will be found in greater quantity.

SPECULAR IRON—see Hematite.

138. SPHALERITE. Blende, zinc blende, black jack, sulphuret of zinc.

Zinc blende is very abundant in California, disseminated through the vein matter in gold and silver mines, but has not been found in distinct veins. When concentration becomes more general in treating low grade ores, zinc will be considered worthy of attention, and will be saved and utilized. It occurs at Meadow Lake, Nevada County, in considerable masses, with galena, pyrite, and chalcopyrite; and associated with yellow copper in the Lancha Plana and Napoleon Copper Mines in Calaveras County (Blake).

It is represented in the State Museum by the following specimens: White Chief Mine, Mineral King District, Tulare County; Dennis Martin's ranch, four miles west of Menlo Park, San Mateo County; with calcite, Small Hill Mine, Santa Catalina Island.

SPHENE—see Titanite.

STALACITE—see Calcite.

STALAGMITE—see Calcite.

STEATITE—see Talc.

139. STEPHANITE. Brittle silver ore, brittle sulphuret of silver. Found in the Morning Star Mine, Alpine County (Dana).

140. STIBICONITE. Partzite, antimony ochre, hydrous oxide of antimony. Partzite is found in abundance in Mono County. It seems to be

a mechanical mixture of stibiconite with other oxides, and is always rich in copper and silver.

Magnificent specimens with free silver are found in the Diana, Kerrick, and Comanche Mines, Blind Springs District, Mono County. Specimens may be seen in the State Museum from the Kerrick Mine, Benton, Mono County; from the Comanche Mine, Blind Springs, Mono County; and with native silver and galena, from the Tower Mine, near Benton, Mono County.

141. STIBNITE. Sulphide of antimony, antimony glance.

Stibnite is not a common mineral in California as far as known, but there are several important localities, some of which are likely to be productive. It is found in small quantities, with cinnabar, in most of the quicksilver mines of the State.

Inyo County. Panamint, in large veins.

Kern County. San Emidio Cañon, township ten north, range twenty-one west, sections nine and ten, S. B. M. This is probably the largest deposit of antimony ore in the State. It is likely to be worked to a considerable extent in the near future; preparations are being made with that end in view. Stibnite has also been found near Kernville in the same county.

Lake County. With cinnabar and chalcedony in quicksilver mines.

Mono County. Head of Bloody Cañon.

San Bernardino County. Centennial Mine, in washed bowlders.

San Benito County. At the Alta Antimony Mine, where it occurs in considerable quantity. This mine has been somewhat worked, but at the present time it has been suspended.

Santa Barbara County. (Dana.)

Tulare County. Mineral King District.

142. STROMEYRITE. Silver copper glance.

It occurs with other silver and copper ores in the White Mountains, Inyo County (Aaron), and is not uncommon in the Inyo Mountains, from White Mountains to Coso.

SULPHATE OF COPPER—see Chalcanthite.

SULPHATE OF IRON—see Coquimbite.

SULPHATE OF SODA—see Thenardite.

143. SULPHUR.

While indications of sulphur are very common in the State, there are but few localities where the mineral occurs in any considerable quantity. The following is the most important:

Colusa County. At Sulphur Creek, where it occurs with cinnabar, petroleum, gold, and other minerals.

Inyo County. Near Little Owens Lake, said to be in considerable quantity.

Kern County.

Lake County. Near Clear Lake and Borax Lake. At this locality, known as the sulphur bank, 1,881,697 pounds of commercial sulphur were produced before it was discovered to be the croppings of a quicksilver mine.

Los Angeles County. Quantity unknown.

Napa County.

San Bernardino County.

San Diego County. At the mud volcanoes described in the second annual report of the State Mineralogist.

San Luis Obispo County.

Santa Barbara County. In the Azufre Mountains.

Tehama County.

SULPHURETS AND SULPHURET OF IRON—see Pyrite.

SULPHURETS OF SILVER—see Argentite.

144. SYLVANITE. Telluride of gold. This rare mineral is said to exist in the Melones and Stanislaus Mines, with other tellurium minerals.

145. TALC. Steatite, soapstone, French chalk. This in various forms is a very abundant mineral in this State, as may be seen by the following localities, mostly represented in the State Museum:

Amador County. Two miles northeast of Jackson; *soapstone* in large deposits and of excellent quality.

Calaveras County. Near Murphy's; also at Rocky Hill and Jenny Lind Hill (Trask).

Catalina Island. The *soapstone* of which the California Indians made cooking dishes, came from this island. This is stated by Abel Stearns, a well known pioneer.

Fresno County.

Inyo County. Alabama Range, a greenish, translucent variety (Aaron).

Kern County. Soapstone Mountain.

Los Angeles County. Fourteen miles below San Pedro, on the coast.

Marin County. Taylorville, Paper Mill Creek.

Mariposa County. Coulterville, *soapstone* of excellent quality, and said to be in large quantities. At Lewis (soapstone). In quartz with gold, Yosemite Mine.

Mendocino County. Township nineteen north, range ten west, said to be in quantity.

Nevada County. Grass Valley, wall rock of Maryland Mine.

Placer County. *Foliated talc* near Auburn. *Soapstone*—Stockbridge Soapstone Quarry and Works, township fifteen north, range nine east. The deposit was formerly worked for gold, which it contains in small quantity. This mineral (soapstone) which exists in large deposits, has been used extensively in lining the furnaces in the Alabaster Lime Works, near Auburn, and found very refractory.

Plumas County. Rock Island Hill.

San Diego County. *Foliated talc* with chalcopyrite.

Santa Clara County. Seven miles from Mount Hamilton.

Sonoma County. Pine Flat, *talc resembling French chalk.*

Tulare County. Tule River *soapstone* of excellent quality, suitable for use as a fine resisting material.

Tuolumne County. *Soapstone* in beds eight feet thick(?)

Yuba County.

TCHERMIGNITE—see Alum.

TELLURIC GOLD—see Sylvanite.

TELLURIDE OF SILVER—see Hessite.

TELLURIUM—see Altaite, Calaverite, Hessite, Petzite, and Tetradymite.

146. TETRADYMITE. Bismuth, with tellurium.

Professor Blake discovered a tellurium mineral in the Melones Mine, Calaveras County, which he thought might be tetradymite, associated with gold. According to Willard, it occurs with massive gold in the Morgan Mine, Carson Hill, and in the Melones Mine, Calaveras County. It is said, also, to be found in the Murchie Mine, Nevada County.

147. TETRAHEDRITE. Gray copper, fahlerz, freibergite.

This mineral is a double sulphide of copper and antimony, of which there are numerous varieties. When it contains silver it is named freibergite. The following are the few known localities in the State:

Calaveras County. At Coulterville and at Carson Hill, associated with gold. Freibergite rich in silver has recently been found disseminated through milk-white quartz in the Live Oak Mine. It is sometimes found in considerable masses associated with chalcopyrite and azurite. A specimen examined by me was found to be to the quartz in the proportion of five per cent, and to contain gold and silver as follows:

Gold	7.5 ounces per ton of 2,000 pounds.
Silver	256.1 ounces per ton of 2,000 pounds.

It is therefore a valuable silver ore, and can be easily concentrated. The quantity is not known.

Inyo County. In the White Mountains, on Jacob's Wonder Mine, Panament, and elsewhere in the county.

Mariposa County. With gold in the Pine Tree Mine.

Plumas County. Irby Holt Mine, Indian Valley.

Tuolumne County. Golden Rule Mine.

148. THENARDITE. Anhydrous sulphate of soda.

Thenardite is found in large quantities with hanksite, tincal, trona, gaylussite, and other minerals, at the works of the San Bernardino Borax Company. For further particulars, see third annual report of the State Mineralogist, 1883.

Thinolite—see Calcite.

Tin Ores—see Cassiterite.

Tincal—see Borax.

149. TITANITE. Sphene, titaniferous iron.

Titaniferous iron is found in iron sand in Spanish Creek, Plumas County (Edman). Sphene is in small hair-form crystals in the granite of the Sierra Nevada (Blake), and in albite, Fine Gold Gulch, Fresno County.

150. TOURMALINE. Rubellite, schorl.

Is a mineral almost invariably found crystallized, of all colors, from opaque black to nearly or quite transparent colorless. The usual colors are: *black* (schorl), *red* (rubellite), *blue* (indicolite), *green* (crysolite), *honey-yellow* (peridot), *colorless* (achroite).

All the tourmalines contain boracic acid, from three to ten per cent. This mineral has never been worked for boracic acid, but is probably a source of that acid in nature, resulting from the decomposition of rocks containing it.

The localities of tourmaline are not many in the State. The following are known:

Calaveras County. In white quartz, schorl.

Contra Costa County. Near Bay of San Francisco.

Fresno County. Fine Gold Gulch; schorl, with quartz and feldspar.

San Bernardino County.

Rubellite (rose colored tourmaline). This very interesting mineral is now observed for the first time in California in the form of long slender crystals from one sixteenth to one eighth of an inch in transverse diameter, with the usual triangular section. Color, a beautiful rose pink, contrasting

well with the matrix of white lepidolite. When ignited, the color disappears and the mineral becomes perfectly white; infusible (Blake).

San Diego County. Schorl, on the north side of San Felipe Valley in feldspathic veins. For description see Report Geological Reconnaissance of California (Blake, folio 304).

Tulare County. *Schorl* in granite on the summit of the Sierra Nevada.

Tuolumne County. Large crystals of *schorl* are found in granite on the summit of the Sierra.

TRAVERTINE—see Calcite.

TREMOLITE—see Amphibole.

151. TRONA. Sesquicarbonate of soda. This mineral is found with salt, thenardite, tincal, hanksite, and gay-lussite, at the works of the San Bernardino Borax Company, and is utilized to some extent in the manufacture of borax. It is also found in Death Valley, Inyo County, and at other localities in the Mojave and Colorado Deserts.

TUFA—see Calcite and Aragonite.

152. TURBITH MINERAL. Yellow sulphate of mercury. Is not found in nature. Specimens taken from the interior of the furnaces at the Sulphur Bank Quicksilver Mine, Lake County, were exhibited by T. Parrott at the Paris Exposition of 1878, and at his request were delivered to the School of Mines, Paris, at the close of the Exposition.

153. ULEXITE. Borate of lime, tiza, boronatrocalcite, natroborocalcite, tinkalzit, cotton balls, sheet cotton, etc. Ulexite is a hydrated borate of lime and soda. The history of the discovery of ulexite in Nevada is given in detail in the third annual report. The following localities are represented in the State Museum: The variety technically known as "sheet cotton," containing free boracic acid, from Death Valley, Inyo County, and borax made from it by decomposing with carbonate of soda; "sheet cotton," from Desert Springs Lake, Kern County, with boracic acid made from it by the Boracic Acid Manufacturing Company of San Francisco.

VARIEGATED COPPER ORE—see Bornite.

154. VESUVIANITE. Idocrase. Is a silicate of alumina, lime, iron, etc., first found in the ancient lavas of Vesuvius, whence the name. It has been found in the Siegel Lode, El Dorado County (Blake). Some years ago, Mr. S. S. Taylor sent a fine specimen to San Francisco from Spanish Ranch.

VITREOUS COPPER—see Chalcosite.

VITREOUS SILVER—see Argentite.

155. VIVIANITE. Among a set of samples from Brea Ranch, Los Angeles County, sent to the State Mining Bureau by Mr. J. W. Redway, of Los Angeles, was one of dark color and earthy texture, containing small nodular masses of a beautiful pale blue color, which were examined and found to be vivianite, or hydrous phosphate of iron. This mineral, which is rare in California, is interesting as leading to the hope that other phosphates, so important as fertilizers, may be found at or near the new locality. There is a specimen of vivianite in the Museum of the State University, which is said to be from a California locality, but, if my memory serves me, this is attended with some doubt. It is reported also at Young's Hill, Yuba County, and near Oroville, Butte County, but no certain information has been obtained. The Los Angeles mineral occurs with asphaltum, at

the well known Brea Ranch deposit. The specimen is marked "Gangue and Country Rock." The mass is a dark colored earthy mineral, with streaks and veins of asphaltic substance, the whole being evidently the sandy desert soil blown over liquid asphaltum and cemented by it. The vivianite is in small inclosed nodules, never larger than a pea, and generally smaller. The mineral is that variety known as blue iron earth or native Prussian blue. It is soft, pulverulent; under the microscope, crypto-crystalline; before the blowpipe, whitens for an instant, then blackens and fuses to a black magnetic globule. It is wholly and easily decomposed, by boiling hydrochloric acid; the solution reacts for iron, which, being separated, the solution gives precipitates with sulphate of magnesia and with molybdate of ammonia. In a closed tube it gives much water. The specimen has been numbered 3538, and placed in the State Museum.

Wood Opal—see Opal and Quartz.

Wood Tin—see Cassiterite.

156. WOLFRAMITE. A mineral numbered 3731 in the museum, was entered as *ilmenite*, which it was supposed to be. Quite lately a specimen was sent to Washington and was there named *samarskite*. Doubt being thus thrown on the mineral, I was induced to make a careful examination of it, and found it to be as above. The reactions obtained were as follows: Color, brown to black; luster, metallic; streak, brown red. Hardness, 4.5. Specific gravity, 7.14. Fuses with difficulty to a bead which is slightly magnetic. In closed tube shows traces of water; partly decomposed by boiling nitro-hydrochloric acid, yields a yellow solution and a voluminous yellow residue; decomposed by fusion with bisulphate of potash, hydrochlorine acid added, gives yellow solution and residue of tungstic acid. From this solution ammonia throws down a heavy precipitate of iron.

Scheelite and cuproscheelite are known in the State, but there is the first instance of the occurrence of wolframite that has come to my notice; the locality is Mariposa County, twenty miles south of Mariposa, near Buchanan.

157. WULFENITE. Molybdate of lead. This mineral is found as yet but sparingly in California, although it is abundant in Nevada and Arizona. It is represented in the State Museum by No. 5351, as small, perfect, tabular crystals, in ore from a mineral vein containing other lead minerals, six miles northeast of Cave Springs, Kern County. In Owens River Valley, Inyo County, the miners are often vexed by finding a heavy yellow mineral in the pan or horn spoon, mixed with the gold prospect, which so much resembles the noble metal that they are frequently deceived by it. It is probably molybdate of lead, the specific gravity of which is from 6 to 7.

Yellow Copper Ore—see Chalcopyrite.

Yellow Ochre—see Limonite.

158. ZARATITE. Emerald nickel, hydrate of nickel, hydrated carbonate of nickel. A rare mineral and one that is never found in large quantities; generally as a thin coating on serpentine and chromic iron. It was observed by Blake on chromic iron in Monterey County. Dr. Trask reported it also with chromic iron at Panoches, Gabilan Mountains, Cañada of San Benito, and in Alameda County. It has lately been found in Mendocino County, in township twenty north, and range fourteen west, on chrome iron. It is said to occur on bowlders of chromic iron.

159. ZEOLITE. The name zeolite applies to a group of minerals which includes at least twenty species; the name is, therefore, indefinite. They are all hydrous silicates of alumina, and generally are found in lavas and amygdaloids. There are several minerals in the State Museum from California which have been provisionally referred to the zeolites, pending future analysis and determination. In lava, North Fork Mining District, Fresno County. In lava, Eureka, Humboldt County. In cellular lava, Soledad Cañon, Los Angeles County.

ZINC ORES—see Blende, Sphalerite, and Smithsonite.

160. ZIRCON. Jargon, silicate of zirconia. Zircon has not as yet been found in place in California, but is abundant in beautiful but small crystals in alluvial sands. In cleaning up hydraulic mines it might be collected by the ton if it had any value, but zirconia is not much used in the arts. The sands and final concentrations from the hydraulic mines are very interesting, consisting as they do of gold, platinum, quartz, barite, magnetite, cinnabar, as well as zircons, and sometimes diamonds. Zircon sands are more abundant in some localities than in others; the following localities are the most important:

Arroyo Seco and Irish Hill. *Amador County;* Spring Valley Hydraulic Mine, Cherokee, *Butte County;* in splendid crystals, Picayune Flat, *Fresno County;* in the sands of the Novarro River, Anderson Valley, *Mendocino County;* and Eagle Gulch and Rock Island Hill, *Plumas County.*

INDEX.

A

B

C

PAGE.

D

F

G

H

I

J

K

L

M

CALIFORNIA STATE MINING BUREAU.

WILLIAM IRELAN, JR., STATE MINERALOGIST.

SIXTH ANNUAL REPORT

OF THE

STATE MINERALOGIST.

PART II.

FOR THE YEAR ENDING JUNE 1, 1886.

SACRAMENTO.
STATE OFFICE.........JAMES J. AYERS, SUPT. STATE PRINTING.
1887.

CALIFORNIA STATE MINING BUREAU.

WILLIAM IRELAN, JR., STATE MINERALOGIST.

SIXTH ANNUAL REPORT

OF THE

STATE MINERALOGIST.

PART II.

FOR THE YEAR ENDING JUNE 1, 1886.

SACRAMENTO:
STATE OFFICE.......JAMES J. AYERS, SUPT. STATE PRINTING.
1887.

From Pres. office.

To his Excellency George Stoneman, *Governor of the State of California:*

Sir: The Trustees of the State Mining Bureau herewith submit their report, in pursuance of the Act of the Legislature entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau,' approved April 16, 1880."

Respectfully,

J. Z. DAVIS,
S. HEYDENFELDT, Jr.,
W. S. KEYES,
GEORGE HEARST,
Trustees.

San Francisco, October 1, 1886.

REPORT OF THE TRUSTEES OF THE STATE MINING BUREAU.

In pursuance of the Act of the Legislature entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau, approved April 16, 1880,' approved March 21, 1885," his Excellency George Stoneman, Governor, appointed J. Z. Davis, Esq., S. Heydenfeldt, Jr., Esq., William Irelan, Jr., Esq., Walter E. Dean, and Hon. George Hearst, Trustees. On the thirteenth day of April, A. D. 1885, a majority of the Trustees organized as a Board, and adopted rules and regulations.

On the thirtieth day of May, A. D. 1886, Henry G. Hanks, Esq., the State Mineralogist, resigned his office, and William Irelan, Jr., Esq., was appointed in his place, and W. S. Keyes, Esq., was appointed as one of the Trustees, in place of William Irelan, Jr., Esq.

REMOVAL.

In consequence of a notice given by Alvinza Hayward, Esq., the owner of the premises, No. 212 Sutter Street, that he intended to rebuild, it became necessary to find other premises for the "Bureau," and the Trustees leased the south half of the third floor and the whole of the fourth floor of the premises known as the New Pioneer Building, on Fourth Street, south of Market, No. 24.

The large collection in the Museum of the Bureau was moved during the month of December, with scarcely any damage. The fourth floor of the premises is used for the Museum, and the south half of the third floor is divided into four rooms: one devoted to the Library, two for storage of duplicates, packing, etc., and one for the office of the State Mineralogist.

MUSEUM.

There are one hundred and twenty flat cases, sixty of which were added by the Trustees, and ten large, upright cases built in the Museum, all of which are full. Seven thousand specimens were entered, classified, and catalogued, by Henry G. Hanks, Esq., former State Mineralogist, and two thousand by the present State Mineralogist, making a total of nine thousand.

Many articles, which are not geological or mineralogical specimens, and which are not kindred to the subjects of Geology, Mineralogy, or Paleontology, have been donated to the Bureau, and as many of them are valuable, interesting, and attractive, the Trustees have deemed it advisable to accept such contributions, and give them a place in the Museum.

A complete rearrangement of the ores and economic minerals of the State, has been made, under the direction of the present State Mineralogist, and such ores and minerals are grouped according to their respective characters, as well as by counties.

FACILITIES FOR RECEIVING SPECIMENS.

Wells, Fargo & Co.'s Express, from the first creation of the Mining Bureau, have transported packages (weighing less than twenty pounds) from all parts of the State, and from the neighboring States and Territories, free of charge, and continue to do so.

The Trustees recognize and appreciate the value and importance of this generous assistance rendered to the Bureau.

VISITORS.

The visitors to the Museum of the Bureau, from March 3, 1885, to November 1, 1886, number four thousand four hundred and seventy-five, as appears by the register, which, however, does not represent the total number, as about fifty per cent of persons visiting the Bureau fail to register.

List of Donors to the Museum of the Bureau Since the Issue of the Fourth Report.

Acker, E. O. C.
Adams, C. J.
Adams, F.
Adams, H. H.
Adams, J.
Adams, Wm.
Aegerter, Wm.
Alderman, E. M.
Allen & Co.
Allen, W. D.
Allman, John
Amador Tunnel, Mill, and Mining Company.
Anderson, M. A.
Angell, S. H.
Angel, Myron.
Attwood, F. H.
Attwood, Melville.
Aubery, L. E.
Ayers, Wm.

Bacon, J. S.
Bailey Bros.
Barley, G. W.
Barnes, Ed.
Bartlett, W. P.
Bartley, J.
Barton, B. F.
Bateman, Wm.
Battersby, Captain R.
Beach, C. E.
Bell, Curtis & Mason.
Bell, N. M.
Bell, Thos.
Bennett, J. W.
Berger, Mr.
Berry, Mrs. F. G.
Big Bend Tunnel Company.
Bilty, Theo.
Birge, F. E.
Blackburn, D.
Bleasdale, J. I.
Bluxome, Jr., I.
Booth, Edward,
Boushey, S.
Borgeson, Mr.
Borrett, F. A.
Bowie, A. J.
Boyd, Thos. W.
Bradley, C.
Braverman, M.
Breese & Wheeler Co.
Brewer, Mr.
Briggs, Wm. H.
Britton & Rey.
Brown, G. L.
Brown, H. S.
Brown, W. R.
Brown, Mrs.
Brown, S. D.
Brownell, L. A.
Bryant, John
Buckminster, P. S.
Budelman, Henry.
Buffington, J. M.
Burling, J. W.
Burrage, C. W.
Bush, Mrs. A. E.

Caduc, P.
Camden, Nagle & Co.
Cardell, J.
Carpenter, E. M.
Carson, H. J.
Chalmers, Lewis.
Chandler, R. P.
Chapman, Capt. Chas.
Chapman, W. S.
Chase, Dr. R. P.
Cheever, E. E.
Cherry, Edgar
Chicago Mining Company.
Christie, J. N.
Choynski, I. N.
Clark Bros.
Clark, C. J.
Clusker, C. C.
Coates, L.
Cobb, H. A.
Coffney, John
Colburn, J. E.
Coleman, J. V.
Coleman, Wm. T.
Colley, J. C.
Collins, John
Collins, R. V.
Collins, S. W.
Comerford, Mrs. J. A.
Compton, H. T.
Congdon, N. C.
Condon, J.
Cone, H.
Connell, S. D.
Cook, J. M.
Cooper, J. W.
Cooper, Mrs. E. B.
Corcoran, Phil.
Coughlin, J. D.
Cox, J. F.
Cox, Mr.
Cozzens, W. J.
Cronise, Wm. H. V.
Crossman, J. H.
Curtis, G. W.
Curtis, Samuel T.
Curtis, S. W.

Daggett, John.
Daggett, R. M.
Dana, A. W.
Dana, Wm.
Dane, R.
Davies, Dr. C. B.
Davis, J. Z.
Davis, Major J. B.
Day, Mrs. H. H.
Dean, Dr. G. S.
De Landresse, H. Clerc.
Didesheimer, P. H.
Dithmer, L. A.
Dobinson & Fairchild.
Doble, D. K.
Dobler, Chas.
Dohrman, Levi.
Dorsey, S. P.
Doss, E. W.
Downie, Murray & Co.
Downs, R. C.
Dozier, A. T.
Drake, Dr.
Dunn, R. L.
Durden, H. S.

Eagle Bird Mining Co.
Elliot, C. E.
Ellis, Captain.
Ellis, J. E.
Emerson, G. W.
Empire Mining Company.
Enright, Jas.

Eustice, J. H. L.

Fair, J. G.
Farwell, J. D.
Faulhaber, Carlos.
Febiger, Col. G. L.
Fenn, T. W.
Ferguson, J. W.
Fielding, F. E.
Fisher, J. M.
Flick, Wm.
Flinn, John.
Fraser, C.
Frecheville, Wm.

Gallagher, A. T.
Gallagher, E. A.
Gallanar, G. W.
Gallatin, A. B.
Garnett, Louis A.
Garnier, T. R.
Garthwaite, E. H.
George, Dr.
Germon & Co., A.
Gilbert, A. D.
Gilligan, J. E.
Gilman, J. M.
Gilson & Jno. Rabe, Messrs. Chas.
Gladding, McBean & Co.
Glass, Louis.
Glassman, J.
Goodall, J. E.
Gould & Curry Mining Co.
Grattan & Co., M.
Gray, Jas.
Gray, S. G.
Green, Dr.
Green, H.
Greenman, H.
Green, W. H.
Gregory, Samuel.
Griswold, A. H.
Gruebele, C. L.
Gumbinner, S.
Guptill, A. N.
Guyer, Henry.

Hall, J. R.
Hale, L. A.
Halsey, A.
Hamilton, John.
Hammond, M. E.
Hanckar, Cavaliere Luigi.
Harford, John.
Harrison, B. A.
Hartley, H. H.
Hatch, P.
Hatch, Thos.
Havens, Al.
Hawes, G. H.
Hayden, O.
Hayward, Col. A.
Healy, P. J.
Healy, Wm.
Hearn, Dr. F. G.
Hearn, J. S.
Heath, R. P.
Heath, Wm. McK.
Herrendeen, Captain L. N.
Herring, G. W.
Heslewood, J. A.
Heuter, G.
Heydenfeldt, Judge S.
Heydenfeldt, Jr., S.

Hill, Benjamin.
Hill, Charles.
Hine, C. T.
Hittell, Mr.
Hobart, C. O.
Holcombe, S. E.
Holiday, W. S.
Holladay, S. W.
Holm, F.
Holt, J. H.
Holtsworth, Joseph.
Homfray, Richard.
Hood, Dr. J. W.
Houghton, S. C.
Houston, W. J.
Howls, A. J.
Hubbard, M. T.
Hughes, C. B.
Hughes, D. F.
Hughes, H.
Hughes, W. B.
Huntley, H. H.
Hutchings, E. P.
Hutchings, M.
Hutchinson, W. A.

Idaho Mining Company.
Irelan, Jr., William.
Ish, James T.
Ives, J. J.

Jacott, D. M.
Jamesworth, Charles.
Jessup, W. H.
Johnston, Dr. W. D.
Johnson, G. G.
Johnson, James.
Johnson, J. F.
Johnson, J. J.
Johnson, Q.
Johnson, William.
Jones, Dr. William.
Jones, E. J.

Katz, M. D.
Keeler, Captain J. M.
Keeler, J. H.
Keeney, G. G.
Kellett, Samuel.
Kellett, William.
Kelly, Captain J. G.
Kennedy, J. F.
Kesseler, J. C.
Keyes, W. S.
Keystone Mining Co.
Klein, P. R.
Knell, A.
Knorp, A. F.
Knowlton, A. L.
Knox & Osborn.
Kunz, G. F.

Lake, W. B.
Ladd & Clement.
Landis, John.
Landresse, H. Clerc de
Lambert, T. G.
La Monte, J. D.
Lawver, A. M.
Leechman, John.
Lemoine, William.
Lent, William M.
Levy, H. M.
Lichenstein, Benjamin.
Linkton, S.

Little Gem Mining Co.
Loomis, J. W.
Love, H. P.
Loveland, H. S.
Lovelock, George.
Lowe, B. N.
Lowthan, Thomas.
Lucas & Co.
Luckhardt, C. A.
Lyle, W. S.

Mactear, James.
Maddox, P.
Maling, H. M.
Manning, J. G.
Martin, J. H.
Martin, W. H.
Martin White Mining Co.
Mason, J.
Mast, C. L.
Matthews, W. H. C.
Maxwell, James M.
Maynard, H. G.
McArdle, William.
McCarthy, W. J.
McDonald Mining Co.
McDougal, W. C.
McGeoghegan, J. T.
McKenzie, Alex.
McLeod, T. D.
McMillan, T.
McNabb, A. M.
McNamee, P. J.
McSwiney, W. B.
McTear, James.
Mellis, D. E.
Minckler, W. D.
Minckler, W. P.
Mining and Scientific Press.
Minor, B. B.
Mitchell, C. E.
Mitchell, F. D.
M senhe mer, M. A
Mollitor, S. F.
Monahan, William.
Monteverde, F. E.
Montgomery, E. L.
Mooklar, Dr. J. P.
Moor, Dr. R. E.
Moore, H. G.
Morgan, D. W. C..
Morizio, Joseph.
Morrison, W. P.
Morse, H. A.
Muths, George.

Nevada City Mining Co.
Nevills Mining Co.
Nevills, W. A.
New London Mining Co.
Newman, C.
Nichols, Mrs. H. C.
Niebur, H.
Noel & Whaley.
North Star Mining Co.

Oliver, William L.
Osborn, G. W.

Parker, Dr. W. C.
Patton, Daniel.
Patton, W. H.
Paul, A. B.
Peño, Domingo.
Pew, J. W.

Pilsbury, Mr.
Pleasants, J. E.
Plymouth Consol. Min. Co.
Pope, William.
Porter, Dr. Thomas.
Price, T. S.
Providence Mining Co.

Quimby, W. C.

Rabe, Dr. John.
Ralston, John.
Ranlett, H. D.
Rathgeb, J.
Rawlings, J. S.
Reavis, J. A.
Redway, J. W.
Reeves, Hon. Truman.
Reis, Gus.
Rhoads, J. C.
Rhodes, M. T.
Rhodes, M. G.
Rice, Judson
Richardson, J. N.
Richardson, L.
Riddell, J. R.
Roberts, A. E.
Robertson, T. F.
Robinson, Chas.
Rodgers, G. W.
Rodgers, Mr.
Ross, C. L.
Rowley, A. B.
Ruffino, S.
Russell Patent Process Co.

Safley, L.
Safley, L. J.
Saltuari, John
Schmidt, H. W.
Schneider, C. G.
Scott, W. G.
Scupham, J. R.
Senderling, J. C.
Shearer, F. E.
Shearer & Rattler.
Sherman, C. E.
Silver, Lowry
Sinton, R. H.
Smith, F. E.
Solis, Brown & Co.
Sonnenfeld, Sam.
Sonner, Ad.
Sorley, Jas.
Soto, M. A.
South Spring Hill Mining Co.
Sparling, Richard.
Spencer, E. G.
Sprague, J. W.
Staddon, Samuel.
Stevens, H.
Stewart, Wm.
Stillwagon, W. W.
Stivers, H. F.
St. John, Edgar.
Stokes, W. C.
Stone, D. C.
Stone, M. D.
Strahle & Co., Jacob.
Strain, R. R.
Strong, S.
Stump, I. C.
Sublette, Wm.
Suggett, J. H.

Tarpey, M. F.
Thomas, R. B.
Thomson, B. M.
Thorn, I. N.
Thorn, J. M.
Threlfall, T.
Towle Bros., Alta.
Trafton, Chas.
Troop, Wm.
Tubbs, Hiram.

Ulyard, Mrs. A. M.
University of Tokio, Japan.

Valentine Mining Co.
Vinzent, G. A.
Vischer, Hubert.

Walker, John.
Waller, Wm.
Walls, Henry.
Ward, A. H.
Ward, H. H.
Wasson, Hon. Jos.
Watts, Claude.
Webster, Frank.
Weldon, W. H.
Wells, W. H.
Weyl, J.
Willard, Z. A.
Williams, Ben.
Williams, F. E.
Williams, G. F.
Williams, Harry.
Williams, J. J.
Williams, L. E.
Willis, Wm.
Wilson, J. Downes.
Wilson, W. C.
Wilton, H. W.
Winegar, A. B.
Winter, J. W.
Winters, T. B.
Woodhull, D. S.
Woodley, Capt. W. J.
Wood, P. J.
Wood, R. E.
Wores, Chas. R.
Wren, Hon. Thos.
Wynants, N.

Yale, Chas. G.
Yamada, K.
Yoder, J. F.
Young American Mining Company.
Young, R. A.

LIBRARY.

A catalogue of the books and pamphlets in the library has lately been prepared, but has not yet been sent to the State Printer for publication.

Many valuable books of reference have been sent to the Bureau by our Senators and Representatives in Congress, and by Hon. J. P. Jones of Nevada.

The various departments of the Federal Government, and particularly the "United States Geological Survey," continue to send valuable books to the library of the Bureau.

A complete set of the reports of the Second Geological Survey of Pennsylvania has been kindly given to the Bureau by the Governor of Pennsylvania, and the following State Geological Survey Reports are also in the library:

Illinois, vols. 1 to 7 (vol. 5 missing).

Indiana, 1869–70–72–73–74–75–78, and 1883; also, 1 vol. of maps.

Iowa, vols. 1 and 2.

Minnesota, 1 vol. from 1872 to 1882; also the First to Twelfth Annual Reports, excepting the Second, Third, and Sixth.

Missouri, Annual Reports 1 and 2, and 1 vol. of the Survey.

New Jersey, 1868–69, and 1874; 1881–82–83–84, and 1885.

Ohio, vol. 1, two parts, and vol. 2, two parts, and 1 vol. of 1869.

The Trustees hope to procure complete sets of the reports of all the States which have made Geological Surveys.

The books in the Library number *one thousand one hundred and twenty-three.* This, however, does not include sixty pamphlet boxes of valuable unbound pamphlets.

NEWSPAPERS.

The following newspapers continue to be sent to the State Mining Bureau free:

1. Arizona *Gazette*, Phœnix, Arizona Territory.
2. California *Demokrat.*
3. Daily Grass Valley *Union*, Nevada County, Cal.
4. *Engineering and Mining Journal*, New York.
5. *Golden West*, San Francisco, Cal.
6. Humboldt *Standard*, Eureka, Humboldt County, Cal.
7. Inyo *Independent*, Inyo County, Cal.
8. *Mining Record*, New York.
9. *Mining Review*, Chicago, Ill.
10. Sierra County *Tribune*, California.
11. Ventura *Free Press*, San Buenaventura, Cal.

ACCOUNTS OUTSTANDING AGAINST THE STATE MINING BUREAU.

The following indebtedness was created by Henry G. Hanks, Esq., while State Mineralogist, prior to the thirty-seventh fiscal year, and remains unpaid. The Trustees recommend the payment of the same:

Advances made by Wells, Fargo & Co.	$3,968 00
Several small accounts for material and supplies furnished to the Bureau, amounting to	218 10

Accounts from April 1, 1885, to October 1, 1886.

Museum, library, and general expense	$4,423 76
Salary of State Mineralogist	4,500 00
Traveling expenses	989 55
Rent at 212 Sutter Street, from April 1, 1885, to December 1, 1885	1,600 00
Rent at New Pioneer Building from January 1, 1886, to October 1, 1886	2,025 00
Expense of moving	302 00
Salary of employés	2,617 00
Total for 18 months	$16,457 31

RECEIPTS.

Balance of appropriation for thirty-sixth fiscal year	$438 64
Paid into State Mining Bureau Fund, April 16, 1885	497 35
Paid into State Mining Bureau Fund, June 30, 1885	222 66
Appropriation for thirty-seventh fiscal year, July 1, 1885	10,000 00
Paid into State Mining Bureau Fund, July 13, 1885	1,284 04
Paid into State Mining Bureau Fund, October 13, 1885	753 30
Paid into State Mining Bureau Fund, January 12, 1886	1,150 05
Paid into State Mining Bureau Fund, April 13, 1886	346 30
Appropriation for thirty-eighth fiscal year, July 1, 1886	10,000 00
Paid into State Mining Bureau Fund, July 13, 1886	972 10
Total	$25,664 44

Appropriation and Mining Bureau Fund.

Total	$25,664 44

DISBURSEMENTS.

Total	16,457 31
Balance of appropriation, and in Mining Bureau Fund	$9,207 13

NEEDS OF THE BUREAU.

The appropriations made for the support and maintenance of the Bureau have always been inadequate to carry out the objects contemplated by the Act by which it was created.

The collection of ores and minerals in the Bureau is of incalculable benefit. Persons seeking to study and compare them are afforded every facility.

A record of the locality of each mineral is kept, and any one who is about to engage in any mining industry can get information of great value.

The Bureau seeks to give as much publicity as possible to all discoveries of gold and silver, as well as mineral substances, which may be useful in the arts and manufactures.

Notwithstanding the advantages which have already accrued to the State by creating the Bureau, the Trustees feel that it can be made more useful to the public, and its importance more generally felt, if sufficient means be placed at their disposal.

The material accumulating will require a gallery to be built on the fourth floor, to properly exhibit the minerals.

A Chemical Laboratory is needed, and can be built on the west side of the third floor.

Many books on Geology, Mineralogy, and Metallurgy are also needed, and should be purchased for the library, as constant application is made for them.

Adolph Sutro, Esq., some time ago, presented to the Bureau a complete set of the rocks of the Sutro Tunnel, seven hundred and eighty in number, from the main tunnel, north and south laterals, and the four shafts; and Mr. Charles Forman donated a set of the rocks of the Forman shaft of the Overman mine, in number four hundred and sixty-eight, taken from every *five* feet from surface to the two thousand three hundred and forty foot level. These are in the Bureau, and have never been determined or classified.

There are also four or five cases of lithological specimens from California, also the wall rocks of many of our gold mines. All these specimens require determination, and in order to properly classify them, microscope slides of each are needed, and the Bureau should be in a position to have this important work done under the auspices of a competent lithologist. Too much attention cannot be paid to the proper classification of the inclosing rocks of our gold quartz mines. Its importance is now universally recognized.

The average miner has generally three names for rocks—granite, slate, and porphyry—and the latter name he gives to every rock which is not slate or granite. The study of rocks congenial to the gold-bearing veins is, and has been, too long neglected.

Every effort is being made by the State Mineralogist to secure specimens of the inclosing rocks of the various mines on the coast.

In this connection it may be said that much credit is due to Melville Attwood, Esq., of this city, who is one of the oldest miners on this coast, and a thorough lithologist. He has made a special study of rocks under the microscope, and has written several valuable papers on the subject, and has frequently presented to the Bureau typical specimens of various rocks, with slides prepared for the microscope, and has also assisted in the determination of a number of wall rocks of our California gold mines.

A record of the condition of every mine, about to be closed, should be kept in the Bureau for future reference.

Sufficient assistance should be afforded to the State Mineralogist to conduct experiments much needed. The proper weight of stamps is an open question among the mining men of this coast. By reference to the report of the State Mineralogist it will be seen that the weight varies from six hundred to one thousand pounds. While it is true that some ores are much harder than others, and some more easily comminuted, yet in some mining districts, where the ore in the various mines is alike in all its characteristics, great differences will be found in the weight of the stamps.

Properly conducted, experiments carried on under the direction of the Trustees or State Mineralogist, in various mining districts, would be the proper method of ascertaining a mean weight of stamp, on a given ore.

The condition of gold after it leaves the battery without contact with quicksilver, and its condition after its separation from the quartz by rollers, should be made the subject of most careful study and microscopic examination, with a view of ascertaining its adaptability to rapid amalgamation, as well as to determine whether or no the pulp should be immediately subjected to concentration without amalgamation. in the batteries or on the outside plates, taking into consideration the percentage, composition, and character of the sulphurets.

The questions of weight and drop of stamps, use of quicksilver, size of screens, discharge of pulp, inclination of plates, condition of the sulphurets, concentration, chlorination, etc., should be investigated by actual experiment in different mining districts on the various characters of our gold-bearing quartz.

The Bureau has a large number of maps of California and of different sections of the State acquired for the purpose of facilitating the making of a good and reliable geological and mining map of the State. The Trustees recommend that such a map be commenced at once, and that every mineral deposit and mine be designated as accurately as possible.

The object which the Trustees mainly have in view, is to encourage the development of the great mineral resources of California.

The existence of the various mineral products which can be utilized in the arts and manufactures, and afford the bases of important industries in the State, have not been made known as widely as desired.

The vast importance of the gold production is beginning to be felt all over the world. No country is capable of producing *more* gold, with the same facility and rapidity, than California.

The great auriferous belt of the State, extending as it does from nearly its extreme northern boundary to its most southern counties, is acknowledged to be without parallel in the world. In the museum of the Bureau, are specimens of gold from thirty counties in the State, and this does not include all in which gold occurs.

The low grade ores, and those which are so abundant, carrying principally auriferous sulphurets, from which the gold is successfully extracted at a small cost and in an easy manner, are those which are now receiving the attention of practical miners.

This industry, contributing so materially to the welfare of the people, should receive the fostering care of the State.

The *Engineering and Mining Journal*, of January 23, 1886, published in New York by Richard P. Rothwell, M.E., and Dr. Rossiter W. Raymond, in reviewing the Fifth Annual Report of the State Mineralogist, commenting on the meagerness of the appropriations made to the support of the Bureau, says:

The once liberal expenditures of the State of California, for the thorough study and description of its mineral resources, have dwindled to an annual pittance, which is a subject for combined regret and ridicule. Whatever may have been the reason for this change, it is a pity that the reaction has gone so far to the other extreme.

It is to be deplored that our Legislatures have, for a successive number of years, seemingly ignored the importance of our mineral deposits.

Our Geological Survey failed for want of appropriations in 1873–4, and has been discontinued ever since; the Mining Bureau was not established until 1880, and has never received the financial assistance needed.

The smallest of the Colonies of Great Britain give more attention and encouragement to their mining interests than the State of California.

The *Mining and Scientific Press*, October 30, 1886, in an editorial on the "Subsidies to Mining in New Zealand," compiled from the "Mines Statement," by the Minister of Mines of New Zealand, made July 6, 1886, says:

What to us in this country seems rather a curious feature is the fact that the Government aids the miners in building roads, prospecting, etc. The cost of roads and tracks undertaken by counties in the gold fields last year amounted to £54,137 ($262,464 45), out of which subsidies paid were £35,630 ($172,805 50), and the cost of similar works undertaken and wholly paid for by the Department of Mines was £16,275 ($78,933 75). So far as the Mines Department is responsible, the total cost of such works constructed and in progress will be, when complete, £150,164 ($728,295 40). Several roads are being built to open up new mines. From time to time Government aid has been given to prospecting, with the object of developing the mineral wealth of the colony. This assistance has been extended to prospecting associations, companies working at deep levels, and laterly, under regulations made by the Governor-in-Council, based on recommendation to the Minister of Mines by the Gold-fields Committee, to the local bodies, and, under special circumstances, to individual parties engaged in prospecting in outlying districts.

Subsidies in aid of the purchase of diamond drills have been given. The Minister of Mines, however, does not believe in this, and has sent to America to try and find a light and portable machine which can bore five hundred feet.

In the last four years the total amount authorized by the Government for the construction of water-races, drainage and tailings channels, roads and tracks, diamond and other drills, and to aid prospecting in the gold fields, has been £244,447 ($1,185,567 95), and otherwise paid by way of subsidies the sum of £131,044 ($635,563 40). Last year the sum authorized for similar works was £76,804 ($372,499 40). They recognize that roads and trails are very important to open up new districts, and spend a great deal of money in this direction to encourage miners to go to new regions.

In view of these facts, the Trustees of the State Mining Bureau earnestly appeal to the Legislature, to give the aid so greatly needed, which will contribute materially to the wealth and progress of the State, and to the prosperity of her people.

The sum of *one hundred and twenty-five thousand dollars* ($125,000) for the two coming fiscal years, is respectfully suggested, as a moderate appropriation for the support and maintenance of the Mining Bureau.

Respectfully submitted.

J. Z. DAVIS,
S. HEYDENFELDT, Jr.,
W. S. KEYES,
GEORGE HEARST,
Trustees.

Note.—Walter E. Dean, Trustee, was absent from the State of California when this report was made.

SAN FRANCISCO, November 17, 1886.

To Honorable GEORGE STONEMAN, *Governor of the State of California:*

SIR: In accordance with the Act of the Legislature entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880, I herewith transmit my report.

Very respectfully,

WM. IRELAN, JR.,
State Mineralogist.

October 1, 1886.

REPORT OF STATE MINERALOGIST.

On the first day of June, 1886, the present State Mineralogist was commissioned by his Excellency George Stoneman, Governor of the State of California, *vice* Henry G. Hanks, Esq., resigned.

Upon assuming the duties pertaining to the office, as prescribed by the Act of the Legislature entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880, the State Mineralogist, upon conferring with the Trustees of the State Mining Bureau, deemed it advisable to obtain such information concerning some of the leading quartz mines carrying on operations on the great auriferous belt of the State, giving such information as would be of interest to the people of the State, and particularly to those persons who are engaged in gold-quartz mining.

The time, during which the State Mineralogist was expected to give his attention to this subject, was so limited that it became impossible to gather much information or many statistics relating to this great industry of the State.

A few of the leading mines, in several of the counties, were visited in person by the State Mineralogist, and he was enabled to collect some data and gather other information from persons familiar with sections of the State which the State Mineralogist was not enabled to visit, who cheerfully gave descriptions of mining operations which were being carried on.

A number of the leading gold mines were necessarily omitted, as well as most of the mines and prospects, which are said to have a promising future. He hopes that in some future annual report he will be enabled to give a full and complete description of the condition of gold and silver mining throughout the entire State, and not be compelled to neglect a description of the localities of other valuable mineral products which exist so abundantly in California, and to report what developments are being made.

It was suggested by the Board of Trustees, that considering the shortness of time in which he would be justified in leaving the Bureau to make his observations, it would be better to chiefly confine his report to a short description of the developments made and the depths of some of the mines, and give such statistics as he could collate, showing the method of extracting the gold and description of the machinery in use.

The grade of the ore being worked in any of the mines visited by the State Mineralogist is not given, for the reason that the mine owners, in common with persons engaged in commercial business or other economic enterprises, do not wish their private affairs given to the public, and do not care to invite any inspection or publication of their books.

The State Mineralogist desires to acknowledge his appreciation of the uniform courtesy and assistance which has been rendered him by the Trustees. The Bureau is greatly indebted to J. Z. Davis, Esq., the Chairman of the Board of Trustees, who daily gives a portion of his time to its progress. Mr. Davis has the success of the Bureau at heart, and has presented many valuable ores and minerals, besides several cases of interesting conchological specimens, and many other attractive exhibits.

THE MOTHER LODE.

This very remarkable auriferous belt runs in a northwesterly and southeasterly direction, and can be traced for about one hundred miles, from the Mariposa estate, in Mariposa County, through the counties of Tuolumne, Calaveras, Amador, and into the county of El Dorado. The lode dips to the eastward at an angle of from 45° to 70° to the horizon. The walls are uniform and the gouge well defined; the vein matter is white and banded quartz, carrying a small percentage of sulphurets. The eastern, or hanging-wall, is greenstone, and the western, or foot-wall, is slate.

Professor Whitney remarks of this lode:

> It is not by any means a continuous bed or vein of quartz, but rather a series of nearly parallel belts of lenticular masses with barren intervals between them, but yet arranged nearly in the same course.

R. H. Stretch says:

> The mother lode is not, strictly speaking, a continuous vein, but rather a belt of gold-bearing rocks, situated in a line of contact between black clay slates on the west and greenstone on the east. On each side of the contact, for a limited distance, the rocks are more or less mineralized with gold, and hence we have, in many cases, a series of more or less parallel locations indicating the points at which the quartz segregations have shown themselves on the surface. When the line of contact is more nearly vertical, the quartz bodies seem to be more solidly compacted and continuous; when it is flatter they seem to be more disseminated through the lateral country rock. Usually there is quartz on the line of contact, and one or more bodies between the hanging and foot-walls.

AMADOR COUNTY.

This county is about fifty-five miles long, with an average width of twelve miles, and although it has less area than most of the other mining counties of the State, it ranks, at present, among the foremost in production of gold. It is bounded on the north by El Dorado County, and by Calaveras on the south, and through its central portion, in a northwesterly and a southeasterly direction, runs the mother lode. East of the mother lode there is a belt of limestone, entering from Calaveras County, passing Volcano and extending toward the Sierras. The formation in the southern part of the county is of a volcanic origin, whilst in the northern portion are the gold-bearing slates.

Throughout the whole extent of the auriferous belts of the county there is an unusual amount of activity, and a decided feeling of contentment, not only in the present satisfactory production of the mines, but in expectation of an enlarged future yield. Properties abandoned in the years gone by, on account of the high price of labor, and the expense of motive power consuming the production, have recently been reopened, and, by the substitution of water for steam, are now in paying condition; again the developments in the new finds are very encouraging.

PLYMOUTH CONSOLIDATED.

As a dividend-paying property, this mine is not excelled by any other on the mother lode. The mine in altitude is 1,050 feet above sea level, has a length of 4,800 feet on the lode; both hanging and foot-walls are slate; the course of the vein is north and south, dips 55° to the east, and has an average width of 30 feet. There are two water power mills on the property of 80 and 40 stamps respectively. In the larger mill the stamps weigh

750 pounds each, whilst in the smaller, the weight of each stamp is 1,000 pounds; the fall of the stamps is 7 inches, at the rate of from 90 to 100 times per minute, crushing about two tons to the stamp every 24 hours. The method of recovering the free gold is by amalgamation in the batteries and collection on the outside plates; the sulphurets are collected on Frue concentrators, and worked by the chlorination process, at the company's works, at an expense of $10 per ton.

The following is the last quarterly report of the company:

The dividend paid on October fifth by the company, was the forty-first consecutive monthly dividend, making a total of $1,775,000. It is stated that the mine has more ore developed than at any previous period in its history. At present the mills are supplied with low grade rock from the upper levels. No stoping has been done in the bottom, the ore there being reserved for future use. The entire plant, including mills, shops, etc., is in perfect running order. Level No. 6 (1,500 feet) has been opened one quarter of its length, and promises to be the best in the mine. Large masses of low grade rock have been uncovered between the 800 and 900 levels, and a new ore body is now being worked on the 800. Its full size is unknown, but appearances indicate an extensive deposit.

GOLD BULLION PRODUCED.

January, 1886	$55,683 47
February	45,611 11
March	53,897 81
April	50,778 91
May	49,502 13
June	44,166 43
July	44,566 75
August	51,528 16
September	51,812 36
Total product for nine months, 1886	$447,547 13
Operating expenses for same period	193,145 00
Profit	$254,402 13
Cash on hand, January 1, 1886	43,081 45
Amount applicable to dividends	$297,483 58
Paid dividends for quarter, Nos. 32 to 40, $25,000 each	225,000 00
Cash surplus, October 1, 1886	$72,483 58

Altitude, feet	1,050
Number of stamps	120
Weight of stamp, pounds	750–1,000
Drop of stamps, in inches	7
Drop of stamps, per minute	90–100
Duty of stamp in twenty-four hours, tons crushed	2
Depth of shaft, vertical, feet	1,500
Length of ore-shoot, feet	800
Average width of vein, feet	30
Percentage of sulphurets	1½
Value of sulphurets, per ton	$135
Number of concentrators	32

KEYSTONE CONSOLIDATED

Is situated at the southeast end of the town of Amador, about two miles northwesterly from Sutter Creek, in the Amador Mining District, and has an altitude of 1,000 feet above sea level. The consolidation includes Spring Hill, Geneva, and Garfield claims. The location was made in 1850, and has since been worked almost continuously. The eastern, or hanging wall, is a metamorphic rock called by the miners greenstone, but so far the foot or western wall is not well defined. Lying against and on the west side of the greenstone is a large vein of low grade quartz; thence westerly there are from 200 to 300 feet of argillaceous slate in which the best ore deposits

occur, thence an admixture of slate and spar in which ore does not exist. The average width of the zone is about 400 feet; the course of the vein is northwesterly and southeasterly. The hanging-wall dips easterly at an angle from 45° to 60° at the surface, and 45° at the bottom; length of the shoot is 800 feet. There are two shafts north and south; the north shaft, used for hoisting the ore from the mine, is 1,305 feet on the incline of 49°, reaching a vertical depth of 1,000 feet; the south shaft, used exclusively for pumping out the water, is 1,125 feet on an incline of from 42° to 55°, with a vertical depth of 780 feet. The nature of the ores is free milling, carrying from one and one half to one and three quarters per cent of auriferous sulphurets. The method of reduction is crushing by stamps, and of recovery is amalgamating in the battery and collecting on copper plates on the outside. On the east side of the contact is a large, poor vein of quartz, varying in thickness from 2 feet to 40 feet, which is very spotted; 200 feet west from the greenstone, in the argillaceous slates, occur the next deposits, which are irregular and confined to a northwest and southeast channel; these deposits are from 2 feet to 30 feet thick, and a better quality of ore than that which is found on the east side. The west channel is from 300 feet to 500 feet west of the greenstone, from 3 feet to 40 feet in ore of the best quality found in the mine, paying as high as $40 per ton.

The sulphurets are iron pyrites combined with a small percentage of arsenical and antimonial sulphurets, and have an assay value of $110 per ton. The method of saving the sulphurets is by Hendy concentrators, riffles, and blanket sluices, and the gold is extracted therefrom at a cost of $20 per ton to the company at the chlorination and leaching works of Barney & Voorhies, Sutter Creek.

The mill is run by water-power; contains 40 stamps of 750 pounds each, with a drop of from 7 to 8½ inches, 96 times per minute, crushing 2½ tons to the stamp in 24 hours. The batteries are both high and low discharge, with number 8 slot screens; the apron plates are 16x14 inches, and sluice plates 14 inches wide. The total length of the plates for the 40 stamps is 80 feet, with an inclination of 3½ inches in 10 feet. The amount of water used in 24 hours, in mill, is 125 inches, with a pressure of 254 feet.

Altitude of mine above sea-level, feet	1,000
Number of stamps	40
Weight of stamp, pounds	750
Drop of stamps, in inches	7-8½
Drop of stamps, per minute	96
Duty of stamp in 24 hours, tons crushed	2½
Size of screens, slot	8
Miner's inches of water used in mill in 24 hours	125
Pressure of water, feet	254
Cost of mining, per ton	$3 50
Cost of milling, per ton	75
Percentage of recovery saved in batteries	85.
Percentage of recovery saved on plates	6-7
Number of concentrators	28
Percentage of sulphurets	1½-1¾
Value of sulphurets, per ton	$110 00
Cost, per ton, of working sulphurets	$20 00
Number of men in mine	90
Number of men in mill	9
Total number of men employed in and about mine	110
Length of ore-shoot, feet	800
Length of ore-shaft on incline, feet	1,305
Vertical depth reached by ore-shaft, feet	1,000
Length of water-shaft on incline, feet	1,124
Vertical depth reached by water-shaft, feet	780

SOUTH SPRING HILL.

This property is two miles northwest of the town of Sutter Creek, and one and one half miles southeast of Amador, in the Amador Mining District, and has an altitude of 1,100 feet above sea level. It is a State of Maine incorporation, but owned principally in Massachusetts. The eastern or hanging-wall is of the same formation, metamorphic, as seen in the Keystone; the foot-wall being slate with a gouge. The dimension of the claim is 600 feet in width, by 1,800 feet in length, with a course running northerly and southerly; an easterly dip, and an average width of vein matter of 22 feet, although in places it reaches 50 feet. The mine is worked through an incline shaft, 800 feet on the incline of about 80°, reaching a vertical depth of 758 feet. The ore is free milling, with the exception of the gold contained in the sulphurets. The method of reduction is crushing by stamps, and of recovery, by amalgamation in the battery and collecting on outside plates; the sulphurets, with an assay value of $125 per ton, in gold, principally iron pyrites, are saved from the sluice tailings by the Frue, Triumph, and Hendy concentrators, and the gold extracted therefrom by chloridizing and leaching at the reduction works of Barney & Voorhies, Sutter Creek, at a cost to the company of $20 per ton.

The mill is run by water power and contains, at present, 20 stamps, although 10 additional stamps have been contracted for, to be put in place at once. The stamps weigh 750 pounds each, have a drop of from 6 to 7 inches, 90 times per minute, and crush 2½ tons in 24 hours. The batteries are low discharge with number 7 slot screens; the aprons and sluice plates are silver plated, the former being 24 feet by 48 inches, and the latter being 15 inches wide by a total length of 128 feet. The amount of water, per 24 hours, used in the mill is 70 inches, with a pressure of 325 feet. Developments and improvements during the year, from January first to August first, consist of upraise from 500 foot level to the surface, a drift of 200 feet on 700-foot level and several back drifts, new retort house; expended $2,000 on hoisting works, and under course of erection an addition of 10 stamps.

Altitude of mine above sea level, feet	1,100
Number of stamps	20
Weight of stamp, pounds	750
Drop of stamps, in inches	6–7
Drop of stamps, per minute	90
Duty of stamp in 24 hours, tons crushed	2½
Size of screens, slot	7
Miner's inches of water used in 24 hours in mill	70
Pressure of water, in feet	325
Cost of mining, per ton	$2 50
Cost of milling, per ton	65
Percentage of recovery saved in battery	60
Percentage of recovery saved on plates	30
Number of concentrators: 2 Frue, 2 Triumph, 5 Hendy; total	9
Percentage of sulphurets	1
Value of sulphurets, per ton	$125 00
Cost of working sulphurets, per ton	$20 00
Number of men in mine	40
Number of men in mill	6
Total number of men employed in and about mine	60
Length of ore-shoot, feet	475
Average width of vein, feet	22
Length of shaft, on incline, feet	800
Vertical depth reached by shaft, feet	758

The dividends of the mine are about $30,000 per month.

THE STEWART MINE,

At Sutter Creek Mining District, town of Sutter Creek, Amador County, is of peculiar interest. This vein, lead, or deposit is simply a large conglomerate of low-grade material, consisting of bunches and stringers of quartz intermixed with decomposed granite, slate, black gouge, and clay. All of this material, or stuff, as the owner terms it, on account of the impossibility of separating the good from the worthless, is passed through the mill. Sometimes bunches are found in the mass that are quite rich, yet a great portion of the deposit seems to contain but very little gold. There are no regular walls, nor any decided pitch to the formation. It was evidently thrown out, and to the east, from the chimney of ore composing the Lincoln and Mahoney Mines. An assay has never been made of the material, therefore there is no means of getting an average valuation. The owner's answer to the question as to yield, was characteristic and sensible: "I put through the mill large quantities of the stuff daily, and the clean-up, over and above expenses, is quite satisfactory." The claim is 400 feet long by 250 feet wide, with an average width of vein matter of 50 feet. The southeast end of the claim, 150 feet in length and 75 feet wide, is excavated to a depth of 80 feet. The excavating is still continued, and the whole mass passed through the mill. The mill, containing 40 stamps of 850 pounds each, with 7-inch drop of 85 times per minute, and crushing 4½ tons to the stamp in 24 hours, is run by water power. The batteries are low discharge with No. 6 slot screens, and the sluice plates, with an inclination of three quarters of an inch to the foot, are 16 inches wide by a length for each battery of 15 feet. The recovery of the gold is by amalgamation in the batteries and collection on the outside plates. There are no assays made of the tailings, consequently it is impossible to state the exact amount of recovery, but the owner gives it as about 60 per cent in the batteries and about 40 per cent on the outside plates. The sulphurets, iron pyrites, having an assay value of $60 per ton, are saved by concentration in the English buddle, and are treated by the chlorination process at the reduction works of Barney & Voorhies, Sutter Creek, at a cost per ton to the owner of $20.

Altitude, feet	1,280
Number of stamps	40
Weight of stamp, pounds	850
Drop of stamps, in inches	7
Drop of stamps, per minute	85
Duty of stamp in 24 hours, tons crushed	4½
Size of screens, slot	6
Miner's inches of water used in mill in twenty-four hours	100
Pressure of water, feet	260
Cost of mining, per ton	40 cents.
Cost of milling, per ton	20 cents.
Percentage of recovery saved in battery, about	60
Percentage of recovery saved on plates, about	40
Percentage of sulphurets	½–1
Value of sulphurets, per ton	$60
Cost, per ton, of working sulphurets	$20
Number of men in mine	19
Number of men in mill	6
Length of ore-shoot, feet	400
Average width of vein, feet	50
Length of main tunnel, feet	400
Length of cross tunnels, feet	200
Depth of shaft, feet	150

MOORE MINE.

The mine is situated near the town of Jackson, in the Jackson Mining District, and at an altitude of 1,500 feet above the level of the sea. The course of the vein is southeasterly and northwesterly, with an easterly dip of 52 degrees. The claim is 3,200 feet long by 1,400 feet wide; length of shoot, 1,200 feet; average width of vein 16 feet, and explored depth, 500 feet. The hanging-wall is greenstone, and the foot-wall black slate. The ore, containing about 2 per cent of sulphurets, is what is termed free milling. The developments are, shaft 400 feet deep, three levels, varying in length from 200 feet to 400 feet, and a fourth level now being opened. The present explorations show an ore body 16 feet wide. The amalgamation is conducted in the batteries and by collection on outside plates. The sulphurets, iron pyrites, are recovered by concentration in buddles and worked for gold by the chlorination process at a cost of $15 per ton. The mill, run by water power, contains 10 stamps, weighing 850 pounds each, with a seven-inch drop, falling 90 times per minute, and crushes 3 tons per stamp every 24 hours. The plates, silver plated, are 48 inches wide and 20 feet in length to each battery. The hoisting works are run by steam. The developments during the year, to June twenty-seventh, are shaft 250 feet deep, two levels, and the retimbering of the old shaft. The ledge on the lower level is opening out so well in both size and quality, and the future prospects of the mine being so encouraging, the owners are taking into consideration the erection of a 40-stamp mill, and purchase of 16 Frue concentrators, and building of chlorination works.

Altitude, feet	1,500
Number of stamps	10
Weight of stamp, pounds	850
Drop of stamps, in inches	7
Drop of stamps, per minute	90
Duty of stamp in 24 hours, tons crushed	3
Size of screens, slot	6
Miner's inches of water used in mill every 24 hours	100
Pressure of water, feet	110
Cost of mining, per ton	$1 75
Cost of milling, per ton	$0 86
Percentage of recovery saved in batteries	50
Percentage of recovery saved in plates	35
Percentage of sulphurets	2
Value of sulphurets, per ton	$130 00
Cost per ton of working sulphurets	15 00
Number of men in mine	15
Number of men in mill	4
Length of ore-shoot, feet	1,200
Average width of vein, feet	10
Depth of shaft, feet	400

DOWNS MINE.

The mine is at Volcano, about twelve miles east of the mother lode, in the limestone belt region, and has an altitude of 2,250 feet above sea level. The course of the vein is northeasterly and southwesterly, with a dip of 77°. The dimension of the property is 600 feet wide by a length of 1,500 feet. The mine and machinery lay idle for some time, but at present everything above ground is in running order, and underground explorations are being carried on as speedily as possible. The property was located in 1877, and up to 1884, at which date work in the mine was discontinued, the gross receipts were $300,000—an average yield of $20 per ton. The hanging-wall is greenstone, and the foot-wall, on which lies a black putty-like

gouge one foot thick, is slate. On the property, beside the hoisting gear, is a 20-stamp, self-feeding, water-power mill; each stamp weighs 600 pounds, has a fall of 8 inches and a drop of 85 times per minute. The ore, excepting the small percentage of sulphurets, is free milling. About 75 per cent of the gold value is saved in the batteries, and about 20 per cent is saved on the outside plates. The sulphurets are recovered by means of blankets and buddles, and are ground and amalgamated in pan and barrel at a cost of $5 per ton. The apron plates are 24 by 50 inches, and the sluice plates are 16 inches wide, with a length, for each 10 stamps, of 35 feet, and an inclination of 1 inch to the foot.

Altitude, feet	2,250
Number of stamps	20
Weight of stamp, pound	600
Drop of stamps, in inches	8
Drop of stamps, per minute	85
Duty of stamp in 24 hours, tons crushed	1¼
Size of screen, slot	9 and 10
Miner's inches of water used in mill every 24 hours	28
Pressure of water, feet	520
Cost of mining, per ton	$3 00
Cost of milling, per ton	1 25
Percentage of recovery saved in batteries	75
Percentage of recovery saved on plates	20
Percentage of sulphurets	½
Cost per ton of working sulphurets	$5 00
Ore-shoots, two of 250 feet each and one of 60 feet, total feet	560
One shaft, feet in depth	433
One shaft, feet in depth	420
Width of vein, in feet	3–4

MAMMOTH OR NEVILL'S MINE.

This property is at Middle Bar, Jackson Mining District, at an altitude above sea level of 1,500 feet. The company's property embraces the mining claim, with an area of 2,206 feet in length by 500 feet in width, and 120 acres of timber land adjoining. The course of the vein is northwesterly and southeasterly, with an easterly dip of 75°, and an average width of 8 feet. The mine is worked through a tunnel, 3,500 feet in length by 8 feet square in the clear, which taps the vein at a depth of 800 feet from the surface. The hanging and foot-walls are greenstone and slate respectively. The sulphurets, arsenical, of which there are 4 per cent, with an assay value averaging $1,500 per ton, are recovered by buddle concentration, and worked by the chlorination process at a cost of $20 per ton. The mill contains 10 stamps, each stamp weighing 750 pounds, with a fall of 8 inches, and a drop of 90 times per minute. Water is the motive power of the mill, 70 inches being used, with a pressure of 750 feet. The plates are 52 inches wide by a length of 25 feet for each battery. At times very rich ore occurs in the vein, especially where the matrix contains a large percentage of arsenical pyrites. This ore, so largely impregnated with native gold, is reduced in the hand mortar. The developments, beside those above mentioned, are 1,600 feet of drifts, 220 feet of uprise, and 40 feet of winze, still sinking in the same rich class of ore as is worked in the hand mortar.

Altitude, feet	1,500
Number of stamps	10
Weight of stamp, pounds	750
Drop of stamps, in inches	8
Drop of stamps, per minute	90
Duty of stamp in 24 hours, tons crushed	2¼
Size of screen, slot	6

Miner's inches of water used in mill, in 24 hours	70
Pressure of water, feet	750
Cost of mining, per ton	$2 00
Cost of milling, per ton	1 00
Percentage of recovery saved in batteries	30
Percentage of recovery saved on plates	20
Percentage of sulphurets	4
Value of sulphurets, per ton	$1,500
Cost per ton of working sulphurets	$20
South ore-shoot, in length, feet	300
North ore-shoot, in length, feet	600
Tunnel, in length, feet	3,500
Number of men in mine	13
Number of men in mill	2
Average width of vein, feet	8

Loyal Lead Mine, near Drytown. Ore is being crushed which averages between $7 and $8 per ton in free gold.

Mr. Mason has a very encouraging quartz prospect near Volcano; there is a well defined ledge in the tunnel, showing free gold in paying quantities.

Marlette Mine. A ditch is being constructed, to carry 100 inches of water, from the Amador Canal to the mine. Hoisting works are being erected in the tunnel, for the purpose of sinking a winze. The works are to be run by water power.

Bunker Hill. Twenty of the forty stamps are being run on the new find at the 700-foot level, and the chlorination works are in full operation.

Gover Mine is running twenty stamps on rock found north of the old shaft.

Volcano Gold Gravel Mining Company, made a clean-up for the season's run of over $19,000.

Mahoney Mine, Sutter Creek. The company commenced operations above ground, and the mill will be started on surface dirt.

The new forty-stamp mill at the Kennedy Mine is near completion, and in a very short time the stamps will be crushing ore from the mine.

ZEILE MINE.

This mine is situated in Jackson Mining District, at an altitude of 1,300 feet above the level of the sea, in a slate formation. The vein has an easterly dip, a nearly north and south course, and averages 30 feet in width, ore and vein matter included. The claim occupies 1,600 linear feet on the lode, and is worked through a nearly perpendicular shaft to a depth of 885 feet. Formation of the hanging wall is metamorphosed slate, and that of the foot-wall is soft blue slate with a gouge of decomposed talc, from a few feet to fifty feet thick.

The product of this mine demonstrates how low a grade of ore may be worked to a profit, when done systematically. The ore, when carefully assorted, with free gold and sulphurets, assays but $4 per ton. After the recovery of the free gold in the batteries, and on the outside plates, the sulphurets are saved on the Frue vanner, and are worked by the chlorination process, at the company's works.

The motive power of the machinery is water, but a steam plant is kept in place, to be used when circumstances require.

The mill contains forty stamps, of 750 pounds weight each, falling 7½ inches, with a drop of 88 times per minute, and each stamp crushing 3.37 tons every 24 hours.

The plates are: Battery, 6 by 50 inches; aprons, 30 by 58 inches; and sluice, 16 inches wide by 144 inches long; with the respective inclinations of 3, 2⅛, and 1¼ inches to the foot.

Altitude, feet	1,300
Number of stamps	40
Weight of stamp, in pounds	750
Drop of stamps, in inches	7½
Drop of stamps, per minute	87–88
Duty of stamp in twenty-four hours, tons crushed	3.37
Percentage of sulphurets	2½
Value of sulphurets, per ton	$100 00
Number of men in the mine	90
Number of men in the mill	5
Total number of men employed in and about mine	115
Depth of shaft, in feet	885
Average width of vein, in feet	30
Number of concentrators	16
Miner's inches of water used for stamps and concentrators in 24 hours	190
Pressure of water, in feet	150
Length of ore-shoot, in feet	400

WORKING LOW BEDS OF GRAVEL.

The following description of a method of working low beds of gravel we take from the *Mining and Scientific Press* of San Francisco:

A few miles from Ione, Amador County, in this State, is the Arroyo Seco Mine, which, as the Spanish name indicates, is situated in the bed of a "dry creek." The ground was known to be rich, but all attempts to work it failed, until J. P. Lambing took hold of the operation. The difficulty was there was no fall, and no way of getting rid of tailings. The pay dirt is about five or ten feet deep, and there is considerable stripping to do.

In order to get rid of the worthless top dirt, there is a large crane or steam derrick. The two engines to operate this are 9x16 inches, and there are two 48-inch upright boilers. They hoist from five to seven tons at a load, on the end of a boom 110 feet long. The dirt is hoisted fifty feet high, swung to one side and dumped, and the tub returned in one and a half minutes. The derrick house, containing the engines and boilers, is on tracks laid on the ground, so that it can be gradually moved up the creek as the claim is worked. With this derrick they can dump the "strippings" 110 feet on each side of the center, allowing the men to get the pay gravel.

Mr. Lambing states that this boom is much easier handled and controlled than those built by the Lakeport Derrick Company builders, who have the reputation of making the best, and it works in every way as well, and in many respects better, than those built in the Eastern States. Mr. Lambing went East to examine all there were and ascertain prices, but resolved to have his made here. In addition to the engineer one man controls the movement of the bucket and derrick, and one man on the boom attends to the dumping.

The pay dirt is washed in sluices, as shown in the engraving. The tailings, small rocks, sand, and water run into a general sump under the tall house shown in the accompanying engraving. Now these tailings and the water have to be removed, as there is no fall and no way to get rid of them except to hoist them out of the way. This is accomplished in a very simple but ingenious manner.

In the sump are two submerged centrifugal pumps, of peculiar pattern, and designed for this particular work. Each has two 11-inch discharge pipes; the capacity is 600 miner's inches of water, or 900 cubic feet per minute. These pumps have no steps or bearings made under water, the whole weight resting on two 26-inch anti-friction wheels.

On the floor above these centrifugal wheels are two 15-inch Knight water wheels fed from the main supply pipe with 68 feet head. These wheels run the submerged centrifugal pumps below and raise the sand, gravel, and water from the sump, throwing the whole debris and water into the flume seen issuing from the side of the pump-house. From this flume the gravel and rocks are shoveled out by men, the water is screened and again returned by a pipe, to be used in sluicing. Sixty-eight feet of water does the washing, pumping, and all.

These 15-inch Knight turbine wheels are giving great satisfaction. Mr. Lambing states that they were formerly running one No. 6 and one No. 8 vertical centrifugal pump with a 12-foot wheel of another pattern under 68 feet head, and 400 inches of water. They had to raise from 100 to 500 miner's inches 36 feet high, but the wheel required too much water, and the pumps so much care the present plant was substituted. Mr. Lambing has been mining for the past 34 years and used all the wheels, but he now has five Knight wheels in use, preferring them to others. This centrifugal double discharge pump will pump sand, gravel, chips, leaves, or anything that will pass through a three-inch mesh.

They have pumped up with the water sand and fine gravel as fast as two men could shovel it to the pump for hours at a time and raised it 36 feet high. These pumps have been in constant use for the past two years and it can not be seen that they are any the worse for the hard usage, though the pumps brought out from the East wore out in five months doing the same work.

There is a large amount of mining ground throughout the Pacific Coast, similar to that at the Arroyo Seco Claim, where the stripping is too deep to admit of working by the old process, but which can be perfectly worked by using these powerful steam derricks to remove the strippings. It is fortunate for the mining interests that these can be built here at the mines, and at no greater cost than they can be had from the East. This whole plant was made by Knight & Co., Sutter Creek, E. A. Rix & Co., agents, No. 20 Fremont Street, this city. Miners who know of ground of a similar character to that described will do well to note the success achieved at Arroyo Seco.

BUTTE COUNTY

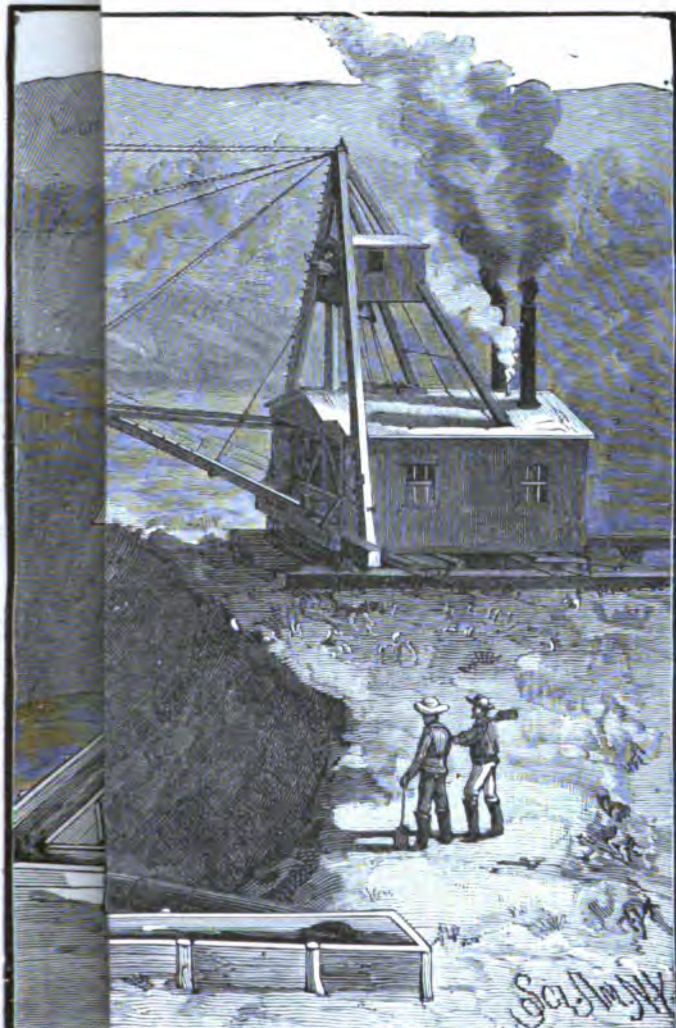
Is bounded on the northwest by Tehama, on the northeast by Plumas, on the southeast by Yuba, on the south by Sutter, and on the west by Colusa Counties. Owing to the exhaustion of the surface placers and discontinuance of hydraulicking, the mining community is thinning out, and the county is falling behind as a gold-producer. Some of the former hydraulic miners have had recourse to drift mining, but the expense is so great by the latter method that they have met with but little, if any, financial success. The geological structure in the gold-bearing section of the county is composed of metamorphic slates, sandstone, and granite. The lava bed region is largely conspicuous in the county.

At Oroville, in Feather River, a company is experimenting in working the river bed through a tubular pile, on the pneumatic principle. The miners complain, whilst subjected to the atmospheric pressure, of a depressive feeling, or lassitude, and a buzzing in the head and ears, more particularly so in the latter case when having a slight catarrh. So far the work is entirely experimental, and we await the result of the undertaking with no little anxiety.

There are a few lone miners drifting in the banks of Butte Creek; but so far none are making anything beyond reasonable wage-hire.

SPRING VALLEY HYDRAULIC GOLD MINE,

Is located at Cherokee, on the north end of Table Mountain, which is crowned by a layer of basalt between 80 and 100 feet deep. The altitude of the mine at bedrock is 1,000 feet. It is one of the largest hydraulic mines in the State, and one of the few in active operation, most of the others having been enjoined by order of the Courts. The average depth, from surface to bedrock, is about 500 feet, by 1 mile in length, and lies in part under Table Mountain, without regard to the conformity of the region in which it exists. In its early history the mine was surface worked by individual locators who held claims, according to the mining laws of the district, of 100 feet square to each locator, and the gold was recovered by means of rockers, long toms, and sluices, respectively, as they succeeded each other, but since 1858 the work has been exclusively hydraulicking. Up to the year 1870 the water supply consisted solely of the drainage of about 10 square miles of territory, on account of the property being isolated from the Sierra Nevada Range by a deep gorge of the Feather River. At this date Egbert Judson and other capitalists interested themselves with H. B. Lathrop, and built reservoirs, constructed ditches, and laid iron pipe across the above mentioned gorge, 30 inches in diameter, 13,100 feet in length, with a perpendicular depression from the grade line of 902 feet. Most of the engineers, looking upon the undertaking as a successful impossibility, advised capitalists not to invest. It is now 16 years since the pipe was placed in position, and work has been carried on without interruption, and with very little cost for repairs; this



pipe furnished 2,210 inches of water every 24 hours for about 8 months of the year. Three years later, to secure a yearly supply of water, additional reservoirs and ditches were constructed, and a pipe, 30 inches in diameter, 3,780 feet in length, with a vertical depression of 630 feet, was laid. The blue gravel, from 10 to 50 feet in depth, lying on the bedrock, carries the greater quantity of gold; thence comes a layer of bowlders, apparently a separate flow, from 3 to 15 feet deep, the most valuable stratum in the mine, yielding from $1 to $8 per cubic yard, and can be removed by hydraulic streams solely; above, intermingled with layers of pipe-clay, is a deposit of fine white quartz gravel and sand, from 20 feet to 400 feet thick. In some parts of the mine the banks have a perpendicular face of 450 feet in height, and it is not an unusual occurrence in the caving for the debris to bury pipes, throwing a 7-inch stream, in position 400 feet distant. The portion of the ground containing the greater amount of gold to the cubic yard was exhausted prior to 1870, and although there are no data to approximate the yield, it is estimated at an excess of $5,000,000. The value of the gold recovered from 1870 to July, 1886, amounted to the sum of $5,008,208 62; for the same period the expenditures were as follows:

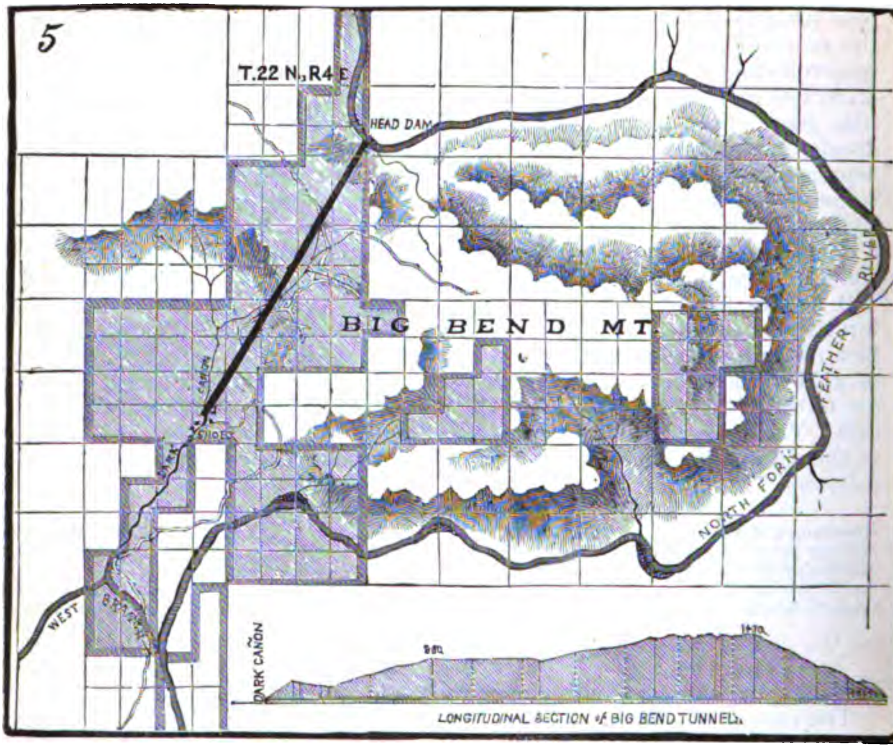
Reservoirs, ditches, and pipes	$510,820 59
Mining plant and tunnels	199,780 55
Mining ground purchased	419,396 18
Land purchased	461,435 87
Cost of debris canal	270,811 48
	$1,862,244 67

Mining expenses, including care and repair of ditches, $1,759,953 77.

The company's water is drawn from nine reservoirs occupying an area of 522 acres, passed through 94 miles of water ditches and 20,940 feet of 30-inch wrought-iron pipe. Among the items enumerated under expenditures, the amounts $461,435 87 for land purchased, and $270,811 48, cost of debris canal, is the actual expense of impounding the tailings. Much of the land originally purchased has since been sold, and about one half its cost has been recovered, yet there is still enough swamp land in possession of the company on which to convey the debris to outlast the mine. The slickens flow through a canal 32 miles long, to two restraining dams 1,800 feet wide, and 12,000 acres of tule land. The mine is worked day and night, 240 men being employed, the after dark illumination being furnished by two 8,000 candle power electric lights.

THE BIG BEND TUNNEL.

This undertaking is without a parallel among the mining ventures of the State. The bend from which the water is to be diverted has a trend not very unlike a horseshoe, with a length, following the meanderings of the water flow, of 13 miles. The purpose for which the tunnel was constructed is to convey the waters of the North Fork of Feather River from their natural course to the tributary of the river's west branch, thereby leaving bare the channel of that portion known as the Big Bend.



Map Showing Tunnel and Big Bend of Feather River.

At the time the water flow was measured, and almost to the period of the tunnel's completion, the quantity was less than for several years previous; consequently the tunnel has not the capacity to accommodate the present body of water confined within the river's banks, and it must, therefore, necessarily be enlarged to add success to the undertaking. The stockholders, however, feel in nowise low-spirited over the present condition of affairs, but look hopefully forward to the expiration of the few months necessary for the required enlargement, when they expect the river bed to yield its auriferous treasure. It is impossible, on account of the steep banks and their rocky formation, to divert the stream in any other way, that will promise a reasonable recompense, than the method adopted. The amount of precious metal concealed by this watery blanket is as yet an unknown quantity, but it is to be hoped that an enterprise so unique and so unwaveringly carried out should receive the reward it so meritoriously deserves.

On account of the formation through which the tunnel passed, slates, granite, quartz, and diorite, there were but few places necessary to secure by masonry. The mouth of the tunnel is in Dark Cañon, near the southeast corner of section eleven, township twenty-one north, range four east. From this point the tunnel runs north, 29° 30′ east, 12,007 feet, to where it taps the North Fork of Feather River. The tunnel, as it is, is 16 feet wide by 9 feet high, with a grade of 30 feet per mile, with the exception of at the head, where for 200 feet, to insure the filling, there is an increased grade. The company will at once commence the work of enlargement, to increase

View off Island Bar, Feather River.

the carrying capacity to 120,000 miner's inches of water. At the inlet, for the purpose of preventing or admitting the water flow, are 6 ponderous iron gates, worked by screws and wheels. A permanent dam, 200 feet long and 16 feet high, is in course of construction across the river just below the inlet. The dam is being built of large timbers, securely fastened to the bedrock and bolted together, after which it will be filled with rocks and covered with heavy planks. A flume for carrying the present surplus of water, not taken by the tunnel, is built from the dam down the river to a distance of 1,007 feet. This flume, 3 feet deep and 18 feet wide, carries a body of water 18 inches in depth with a flow of 10 feet per second. Along this flume the channel is bared sufficiently to allow prospecting of the river bed. Work on the tunnel began in July, 1882, and the water was turned therein in July, 1886. The cost thus far, as near as can be approximated, is $750,000.

CALAVERAS COUNTY.

The county is bounded on the northwest by Amador, on the northeast by Alpine, on the southeast by Tuolumne, and on the southwest by Stanislaus and San Joaquin Counties. Bear Mountain Ridge, a belt of metamorphic rocks, strikes northerly across the central portion of the county, reaching from the Stanislaus River to the vicinity of Calaveras River, separating the copper belt from the auriferous slates. The limestone belt

enters the southwestern part of the county, from Tuolumne, and is more extensively exposed at Murphy's.

At Angels the exploitation is on the auriferous belt about 200 feet to the east of the mother lode; it is a large vein, in talcose slates, but low grade.

THE STICKLES GOLD QUARTZ MINE

Is located in Angels' Mining District, at the north end of Angels' Camp, at an altitude of 1,800 feet above sea level. The dimension of the claim is 300 feet by 600 feet; the course of the vein is northwest and southeast, having a dip of 90° to the east and an average width of 12 feet.

The mine is worked through a three-compartment shaft 400 feet deep, the vein showing at all points. Upon the property is a wet crushing mill of 20 stamps, each stamp weighing 900 pounds, having a 7-inch fall, a drop of 80 times per minute, and crushing 3¾ tons of ore every 24 hours. Seventy per cent of the yield is recovered by amalgamation in the battery, and 30 per cent is collected on the outside plates. The sulphurets, averaging 2 per cent of the ore, are saved by Cornish buddles, and have an assay value of $120 per ton. Hoisting and pumping are done by steam power. The sluice plates, silver plated, are 4 feet wide, 11 feet long, and have an inclination of 1¾ inches to the foot. Developments in the mine consist of four levels at 60, 200, 250, and 400 feet deep, respectively. The level at the depth of 60 feet runs north and south from the shaft, in each direction 30 feet; at 200 feet the level runs south 150 feet, north 200 feet; the 250-foot level has the same course and a corresponding distance, north and south of the shaft, as the 200-foot level; the 400-foot level runs 200 feet north from the bottom of the shaft; all of these levels are on the vein, which has not been stoped out anywhere more than 30 feet above the levels.

Altitude, feet	1,800
Number of stamps	20
Weight of stamp, pounds	900
Drop of stamps, in inches	7
Drop of stamps, per minute	80
Duty of stamp in 24 hours, tons crushed	3¾
Size of screen, slot	9
Percentage of recovery saved in batteries	70
Percentage of recovery saved on plates	30
Percentage of sulphurets	2
Value of sulphurets, per ton	$1 20
Cost of mining, per ton	1 50
Cost of milling, per ton	75
Number of men in mine	24
Number of men in mill	6
Depth of shaft, vertical, feet	400
Length of ore-shoot so far as developed, feet	400

THE UTICA MINE,

Angels, Angels Mining District. The claim is 300 feet wide by a length of 634 feet. The course of the vein is northwest and south, dipping 85 degrees to the east, and averaging in width 20 feet. The 20-stamp mill has both water and steam power. Each stamp weighs 950 pounds, drops 8 to 9 inches at the rate of 80 times a minute, and crushes 3 tons of ore every 24 hours. The plates, with an inclination of 1¼ inches to the foot, are 52 inches wide and 10 feet in length to each battery.

Number of stamps	20
Weight of stamp, pounds	950
Drop of stamps, in inches	8-9
Drop of stamps, per minute	80

Duty of stamp in 24 hours, tons crushed	3
Size of screens, slot	9
Percentage saved of recovery in battery	75
Percentage of recovery saved on plates	25
Percentage of sulphurets	2
Percentage of sulphurets, per ton	$60 00
Cost of mining, per ton	$2 50
Cost of milling, per ton	$0 60
Depth of shaft, feet	140
Miner's inches of water used in 24 hours	150
Pressure of water, feet	100
Number of men in mine	25
Number of men in mill	6

ANGEL'S GOLD MINE.

This mine, in Angel's Mining District, has not been worked for the past few months, but will shortly be again in active operation; in fact, preparatory steps have already been taken to commence work. The claim is 1,354 feet in length, by a width of 600 feet. The vein, with a north and south course, is 20 feet wide, and has an easterly dip of 15 degrees. The developments consist of two shafts 100 feet, each, in depth and 300 feet apart, connected by a level. The improvements are, two J. B. Low mills, each having a capacity of 20 tons in 24 hours, two hoisting plants, pump, air-compresser, and four Frue vanners.

DEEP LEAD PLACER MINE,

In Mokelumne Hill Mining District, was located in 1880, and has been worked continuously ever since. During the first year an incline was sunk 380 feet, to the channel, which is vertically 130 feet from the surface. Since then the developments are 2,600 feet along the channel, besides sixteen crosscuts, of an average length of 50 feet each. The perpendicular depth from the surface to the face of the present workings is about 425 feet. The course of the channel is north and south, having a width varying from 40 to 60 feet, and in length about one and a half miles. The improvements consist of an 8-stamp water-power mill, three hurdy-gurdy wheels, one being 4 feet and two being 6 feet in diameter; one water-power hoist, and one 6-inch by 5-foot stroke plunger pump. Of the water, which has 225 feet pressure, there is used for the mill 20 miner's inches, and 12 miner's inches each for the hoist and pump every 24 hours. Five per cent of the gold recovered is by the batteries and ninety-five per cent on the outside plates. Each stamp weighs 750 pounds, falls 9 inches, at the rate of from 85 to 87 times per minute, and crushes five carloads of gravel every 24 hours. Developments during the year are 700 feet of tunnel and four crosscuts of 5 feet each.

Number of stamps	8
Weight of stamp	750
Drop of stamps, in inches	9
Drop of stamps, per minute	85–87
Duty of stamp in 24 hours, carloads crushed	5
Size of screen, steel wire, meshes to the inch	5
Average value. per carload	$1 00
Percentage of recovery saved in batteries	5
Percentage of recovery saved in sluices	95
Number of men in mill	1
Number of men in mine	5
Miner's inches of water used in 24 hours:	
For mill	20
For hoist	12
For pump	12
Pressure of water, feet	225

SHEEP RANCH MINE.

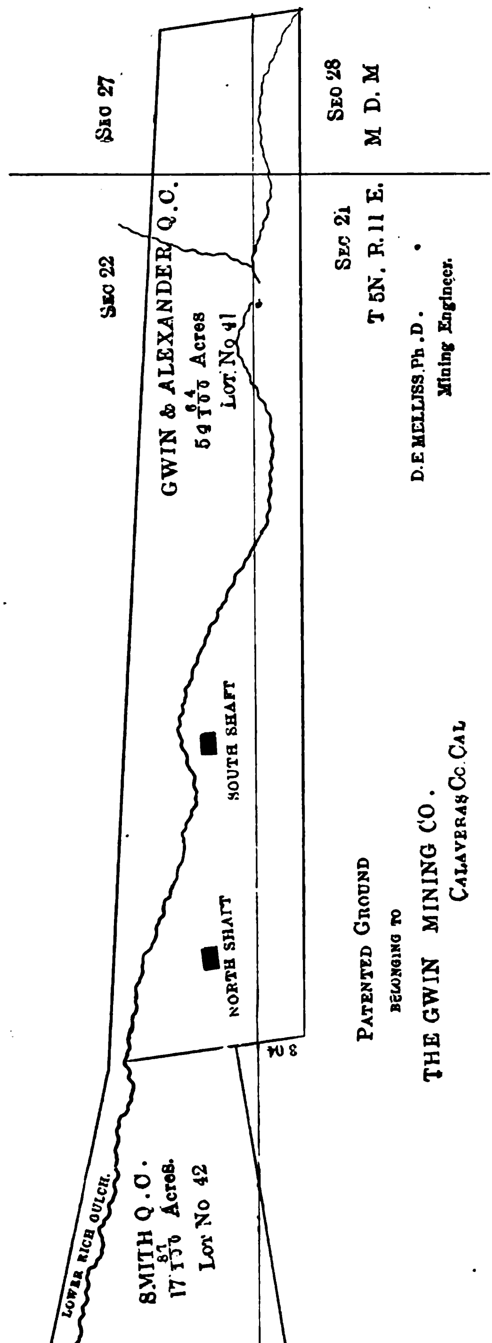
This, the principal mine in the Washington Mining District, is situated on San Antonio Creek, a tributary of the Calaveras River, at an altitude of 2,200 feet above sea level, in a slate formation. The claim is 1,600 feet in length by 200 in width; course of the vein northwesterly and southeasterly; dip easterly, and average width 12 inches. Hanging-wall is a grayish slate and foot-wall a hard black slate; the ore is a ribboned, free milling quartz. All the ore has been taken out down to the 800-foot level; the mill is at present crushing rock from the above and the 900-foot levels. During the year the shaft has been continued down 100 feet and 1,000 feet of levels have been run. The mill, wet crusher, 30 stamps, is run by steam power; each stamp weighs 800 pounds, falls 8 inches 85 times per minute, and crushes 2¼ tons of ore every 24 hours. Eighty per cent of the recovery is obtained from the batteries and 20 per cent is collected from the outside plates. The sulphurets are so low in value that it is not worth the while to save them. The apron plates having an inclination of 2 inches per foot, are 4 by 10 feet, and the sluice plates inclining 1½ inches to the foot are 15 inches wide, with a total length of 100 feet.

Altitude, feet	2,200
Number of stamps	30
Weight of stamp, pounds	800
Drop of stamps, in inches	8
Drop of stamps, per minute	85
Duty of stamp in 24 hours, tons crushed	2¼
Average width of vein, in feet	1
Depth of shaft, in feet	900
Length of ore-shoot, in feet	1,200
Size of screens, diagonal slot No.	9
Percentage saved of recovery in batteries	80
Percentage saved of recovery on plates	20
Cost of mining, per ton	$3 00
Cost of milling, per ton	$4 00
Number of men in mine	40
Number of men in mill	7
Brakemen, blacksmiths, teamsters, etc.	18

THE GWIN MINE.

The following description is contributed by D. Ernest Melliss, Ph.D., Mining and Civil Engineer, as a record of deep mining on the gold belt of California:

The mine is situated in the Mokelumne Hill or Middle Bar Mining District, six miles north of Valley Springs, Calaveras County, at an altitude of 1,300 feet above the sea. The property comprises two United States patent claims, contiguous to each other, as shown in the accompanying map. These claims cover 4,989 feet, lineal, on the mother lode, with a total surface area of 69.61 acres. The mine was taken up by the late Senator, Wm. M. Gwin, in 1867; he purchased the Alexander Mine in 1872, and the Smith Mine in 1881; the property was incorporated under the name of the Gwin Mining Company.


Sec 27
Sec 28
M. D. M
Sec 22
GWIN & ALEXANDER Q.C.
59 64/100 Acres
Lot No 41
Sec 21
T 5N. R. 11 E.
D. E MELLISS, Ph. D.
Mining Engineer.
SOUTH SHAFT
NORTH SHAFT
8 04
Patented Ground
belonging to
THE GWIN MINING CO.
Calaveras Co. Cal
SMITH Q.C.
17 87/100 Acres
Lot No 42
LOWER RICH GULCH.

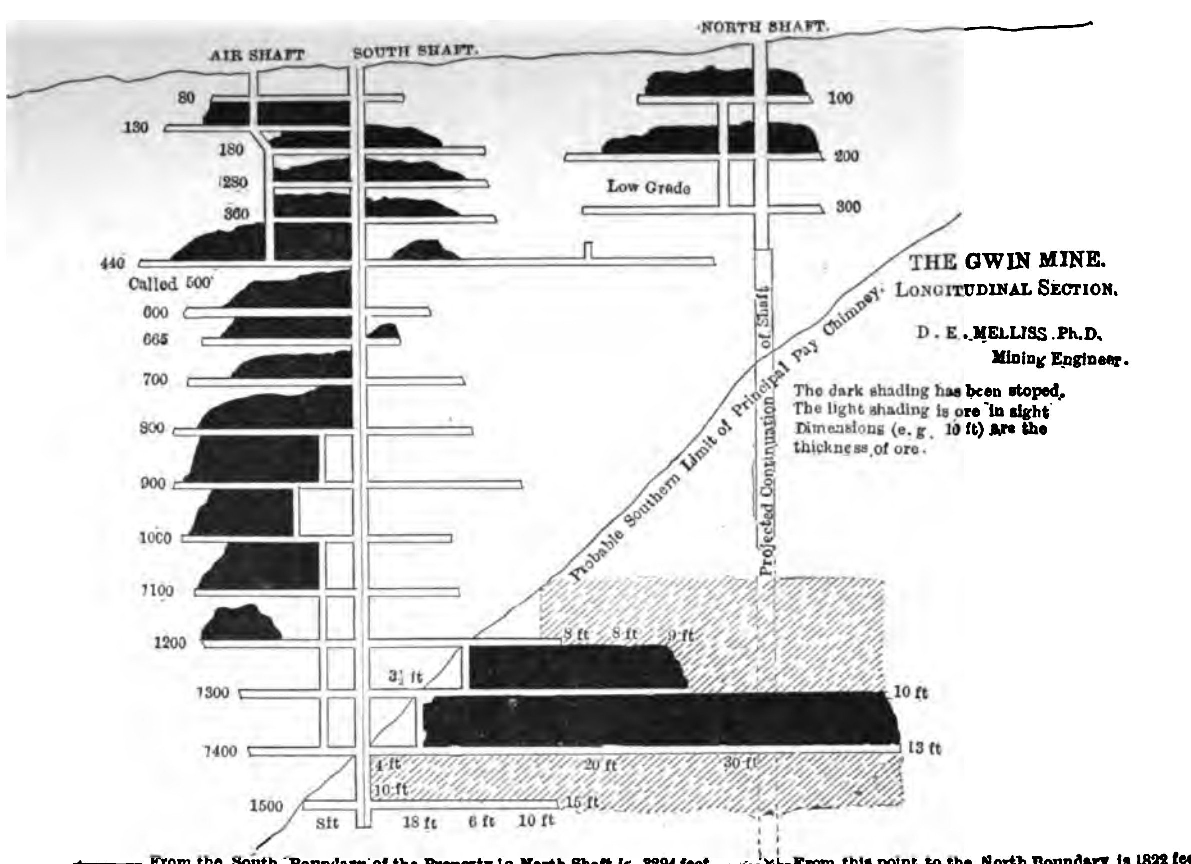
The country rock is slate; the vein strikes nearly due north, true meridian, and dips 75° to 80° to the east. The ore in the mine is white and banded quartz, carrying free gold and auriferous iron sulphurets, with occasional admixture of blende and galena. The average value in free gold is about $8 per ton of ore, although, at times, exceedingly rich bunches of auriferous quartz have been found. The sulphurets are about one and one half per cent of the ore, and the value of the concentrations is about $100 per ton. The retorted gold ranges in fineness from 850 to 875. The south shaft (see accompanying longitudinal section) has been sunk to a depth of 1,530 feet. It is an incline, and follows the foot-wall of the vein. Prior to 1877, considerable ore was taken out from the different levels above the 1,200. In April, 1877, the main ore chimney was struck, and it is on the character of this chimney, as developed by the workings in the 1,200, 1,300, 1,400, and 1,500 levels, that the value of the mine now depends.

The 1,200 level, which has been driven 370 feet to the north, strikes the pay chimney 160 feet from the shaft. No stoping of the north ore body has been done above this level. Of this level, 110 feet are in pay quartz, which is 3 feet thick at the commencement, and widens to 8 feet at the breast.

In the 1,300-foot level the chimney is struck 100 feet from the shaft; the level has been driven to a distance of 640 feet, of which 540 feet was in ore; at the breast it is 13 feet thick. The ground between the 1,300 and 1,400 levels has been taken out, as shown; the top of the stopes on the 1,200 line showing 8 to 9 feet of ore. At the 1,400 level the shoot crosses the shaft; the level has been driven 1,040 feet, all in pay ore; stoping has been done to the 1,300 level, as shown. The ore was 5 feet at the shaft, but in the length of the level widened once to 20 feet, again to 30 feet, and is 13 feet at the breast. The 1,500 level has been driven 100 feet to the south, and 370 feet to the north, all in pay ore. At the south breast the limit of the ore body in that direction has been reached; at that point it is 5 feet thick; at the north breast the ore is 15 feet thick, at the shaft 10 feet, and between that point and the north end it varies between 6 feet and 18 feet.

The mine has produced in all, over $2,000,000 of gold. The exact amount cannot be ascertained. From partial records in possession of the owner, one is enabled to glean the following details in regard to the bullion product. It may be remarked incidentally that the mine was carried on always as a family concern, the money was distributed every month as fast as procured, and no surplus was ever allowed to accumulate. Prior to 1877 no care was taken to make or preserve any records. No records at all for the years from 1867 to 1871 existed, although 40 stamps were constantly running. From April, 1877, till September, 1881, the greater portion (but not all) of the gold produced was deposited in the Pacific Bank of San Francisco.

There are records of weekly shipments of bullion (with some intervals) extending over the period from April 7, 1871, to August, 1882. In none of these statements is the bullion from sulphurets included, except in one instance, a shipment on December 24, 1874, in amount $11,565. The summary of these data is shown in the following table:


THE GWIN MINE.
LONGITUDINAL SECTION.
D. E. MELLISS. Ph.D.
Mining Engineer.
The dark shading has been stoped.
The light shading is ore in sight
Dimensions (e. g. 10 ft) are the
thickness of ore.
AIR SHAFT
SOUTH SHAFT.
NORTH SHAFT.
80
130
180
1280
360
440
Called 500
600
665
700
800
900
1000
7100
1200
7300
7400
1500
100
200
300
Low Grade
Probable Southern Limit of Principal Pay Chimney
Projected Continuation of Shaft
8 ft
8 ft
9 ft
10 ft
13 ft
3½ ft
4 ft
20 ft
30 ft
10 ft
15 ft
8 ft
18 ft
6 ft
10 ft
From the South Boundary of the Property to North Shaft is 3294 feet.
From this point to the North Boundary is 1822 feet.

PARTIAL STATEMENT OF BULLION FROM GWIN MINE.

Date.	Part of Mine.	Amount.
April, 1871, to June 26, 1872	400 level.	$90,353 00
July 8, 1872, to December 26, 1872	500 level.	53,808 00
January 1, 1873, to October 5, 1873	600 level.	118,551 00
November 25, 1873, to February 15, 1874	700 level.	29,214 00
April 26, 1874, to August 30, 1874	800 level.	81,516 00
September 25, 1874, to April 8, 1875	900 level.	73,509 00
April 19, 1875, to June 24, 1876	1,000 level.	80,012 00
January 30, 1876, to March 26, 1877	1,100 level.	135,338 00
April 12, 1877, to October 1, 1879	1,300 and 1,400 level.	446,349 00
October 9, 1879, to September 23, 1881	Above the 900 level.	259,413 00
December 3, 1881, to August 4, 1882	Above the 900 level.	31,083 00
Total		$1,399,146 00

The mill and hoisting works were old and entirely worn out. There were two quartz mills, one of 36 and one of 24 stamps. The stamps weighed only 500 pounds, dropping 75 times per minute. The mortars were old fashioned. The concentrators were concave buddles and sluice boxes. The 60 stamps did not have the crushing capacity of a modern 40-stamp mill. Furthermore, although there are no records relating to the subject, the character of work done in saving gold must have been very poor.

No steam is required for power either for mill or hoisting works. The Mokelumne Hill and Campo Seco Water Company's ditch passes above the mine, giving 300 feet head at the hoisting works delivered through a pipe 100 feet long. To pump and hoist from the 1,500 level, and run 60 stamps, required 180 miner's inches. The cost is about 16 cents per 24-hour inch.

Regarding the water in the mine, no difficulty was ever experienced in keeping it under control till the 1,400 was reached, with a 5-inch pump 30-inch stroke, running 8 strokes per minute. At the 1,500 a slightly increased amount was met with which the same pump could have controlled were it possible to increase the speed; this, however, could not be done, owing to the crooked condition of the shaft.

FINE GOLD MINE.

The mine is situated at an altitude of 3,000 feet above the level of the sea, in Railroad Flat Mining District, and is 1,500 feet in length by 600 feet wide. The course of the vein is north and south, dipping 70 degrees westerly, and averages 5 feet in width. The hanging and foot walls are slate, and the quartz is free milling, containing about 2 per cent of sulphurets, but not of sufficient value to pay for collecting and working. Developments on the property, beside the shaft 250 feet in depth, are three levels running north and south on the vein, from 400 feet to 600 feet in length, all of which were made during the year 1886. The machinery consists of water power, 10-stamp mill, hoisting works, and air compressor. The stamps weigh 750 pounds, drop 7 inches 100 times per minute, and crush 21 tons of ore per day. The apron plates are 4 by 4½ feet, and the sluice plates are 16 inches wide by a length of 100 feet to each battery. The saving of the yield is about equally divided between the batteries and plates.

Altitude, feet	3,000
Number of stamps	10
Weight of stamp	750
Drop of stamps, in inches	6
Drop of stamps, per minute	100
Duty of stamp in 24 hours, tons crushed	$2\frac{1}{10}$
Size of screens, mesh	40
Miner's inches of water used in 24 hours in mill	35
Miner's inches of water used in 24 hours in hoisting works	35
Miner's inches of water used in 24 hours in compressor	35
Pressure of water, in feet	300
Cost of running, per ton	$4 00
Cost of milling, per ton	$1 00
Percentage of recovery saved in batteries	50
Percentage of recovery saved on plates	50
Number of men in mine	39
Number of men in mill	3
Total number of men employed in and about mine	47
Depth of shaft, in feet	250
Length of ore-shoot, in feet, so far as explored	200
Average width of vein, in feet	5

WILLARD MINING COMPANY.

(Contributed by F. B. Morse, E.M.)

The property belonging to the Willard Mining Company is situated in Calaveras County.

Murphys Mining District.—The altitude is about 2,200 feet above sea level. The formation is limestone and slate. The accompanying sketch marked Fig. 1 is a diagram of the formation; the line marked cc′cc being the line of contact. The apparent stratifications of the slate and limestone are conformable and run nearly east and west, the line of the contact cutting the formation. The positions of the different veins are also shown in this diagram. They consist apparently of a main opening, marked AA, and small side veins, marked BB, DD, etc., running into the main opening on either side.

The main vein, AA, is called the "Red Wing" vein. The dip of this vein, as far as known, is nearly vertical; course about 15° north of west and south of east. The dip of the side veins is about 78° to the south; course nearly east and west. We have six locations covering the different veins, five being 600 by 1,500 feet, and one being 300 by 1,500 feet.

We have opened two shoots or bodies of ore on the main opening, one marked MM and the other NN. The length of either is not fully known, but in each case is probably about 1,000 feet. The width between walls varies up to 300 feet, with a maximum width of the ore bodies of 200 feet.

The ore body MM is opened by a tunnel, marked TT, 800 feet into the hill. This tunnel crosscuts the vein. The crosscut shows both walls, at this point, to be limestone. The opening between lime walls is 300 feet. In this opening is 200 feet of vein matter, with 50 feet of birdseye porphyry on either side of the vein between it and the lime walls.

From the point marked c′, the vein, going westerly, follows the contact between the lime and the slate, the north wall being lime and the south wall slate, the contact and the vein cutting the formation at an angle of about 15°.

From the point marked c′—going easterly—the contact makes a bend towards the south. The vein, however, does not follow the contact, but continues its course, cutting across the limestone, both walls now being lime. The main vein here still cuts the formation at an angle of 15°, the side veins running into it being conformable with the apparent stratification.

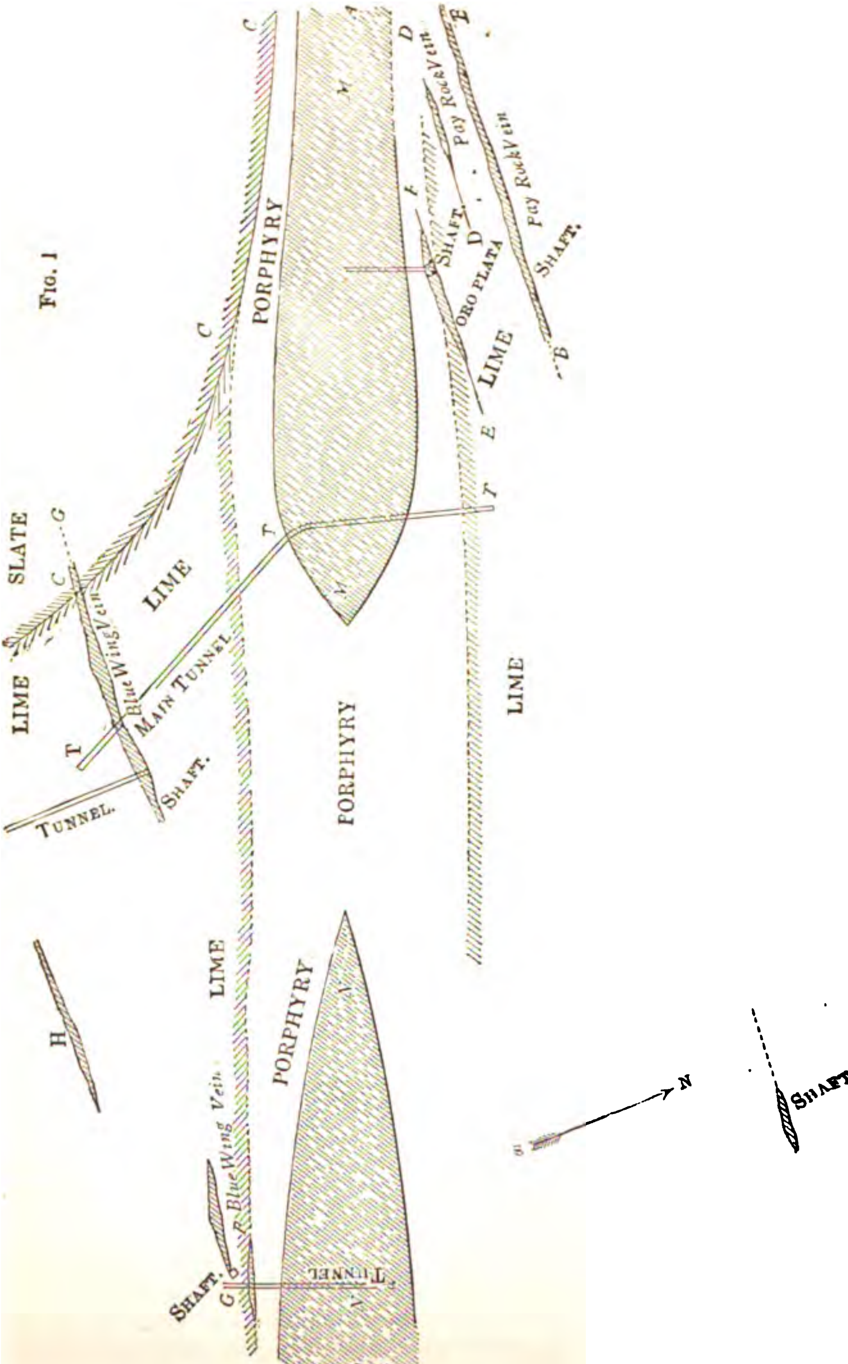

SLATE
LIME
LIME
PORPHYRY
PORPHYRY
PORPHYRY
LIME
LIME
LIME
Blue Wing Vein
Blue Wing Vein
MAIN TUNNEL
TUNNEL
TUNNEL
SHAFT
SHAFT
SHAFT
SHAFT
SHAFT
ORO PLATA
Pay Rock Vein
Pay Rock Vein
N
S
H

FIG. 1

The ore in all the veins is an exceedingly hard quartz, carrying gold, silver, and what is nominally gray copper, galena, and zinc blende. This ore has several interesting peculiarities. In the first place, it carries absolutely no iron pyrites—which are found in considerable quantities in every other gold-bearing vein in our section, outside of this particular belt of veins. Again, the gray copper—or what is nominally such—is shown by analysis to contain very little sulphur—which is largely, and, in some cases, almost entirely replaced by selenium. And besides copper, the mineral carries gold, silver, lead, zinc, bismuth, antimony, iron, and manganese.

Another peculiar feature of the main vein is this: In cross-cutting the vein in the tunnel TTT, the quartz for the first 150 feet carried free gold, and the sulphurets were nominally pure gray copper, no galena or zinc blende being found. The ore assayed ounce for ounce in silver and gold; and the loose gold in the clay seams was worth about $19 an ounce. For the last 50 feet the quartz carried little or no free gold. The sulphurets were galena and zinc blende, and the loose gold was very silvery—being worth only $14 an ounce. The sulphurets here assay from 6 to 8 ounces in silver to 1 of gold.

The same peculiarity is noticed in all the side veins; those on the south side of the main opening carrying free gold and gray copper, with no galena or zinc blende; while those on the north side carry little, and in some cases, no free gold, and no gray copper, but carry galena and zinc blende assaying high in silver.

In the main opening AA the vein-matter between the porphyry walls consists of strata of quartz and porphyry. For a depth of 300 feet, in some cases, from the surface, the vein is decomposed and disintegrated, so that it bears some resemblance to a gravel-bank, though the quartz is all sharp. This decomposition has broken up the quartz into pieces from many tons weight down to fine sand, and the porphyry in many places has been changed to clay.

Our method of working this vein is by an open cut from the surface, making a funnel-shaped hole, connected by a shoot with a tunnel below, through which all the material mined is run out. The sketch marked Fig. 2 shows the present appearance of the pit and of the arrangement of the tunnel.

The tunnel is run in from the surface, so as to partly cross-cut the formation. The grade of the tunnel is about 5 inches in 12 feet, and it is wide enough to allow a track, flume, water pipe, and air pipe to run all the way in. At the end of the tunnel, and under the pit, is a chamber 9 feet by 25, and 20 feet high in the clear. This chamber is connected with the workings above, by what is now a short shoot. At the bottom of this shoot is a large gate; below the gate is a grizzly and a platform and a small bin, for loading into a car. The flume which runs through the tunnel comes in under the grizzly, and the water pipe connects with a small tank at the head of the flume.

Our method of working, in detail, is as follows: In the open cut we run powder drifts, with TT, as in bank blasting. We run the drifts in about 15 feet from the face of the bank, and the TT from 15 to 20 feet on either side, usually taking a 15-foot face to the bank, on a stope up from the bottom. We load from 150 to 300 pounds of powder (low-grade powder) in each T, and fire by battery. One such shot will dislodge from 3,000 to 4,000 tons of material, which is thrown down to the bottom of the pit and into the shoot. It is then drawn from the shoot as fast as wanted, by means of the gate. As it comes through, it passes on to a grizzly, the

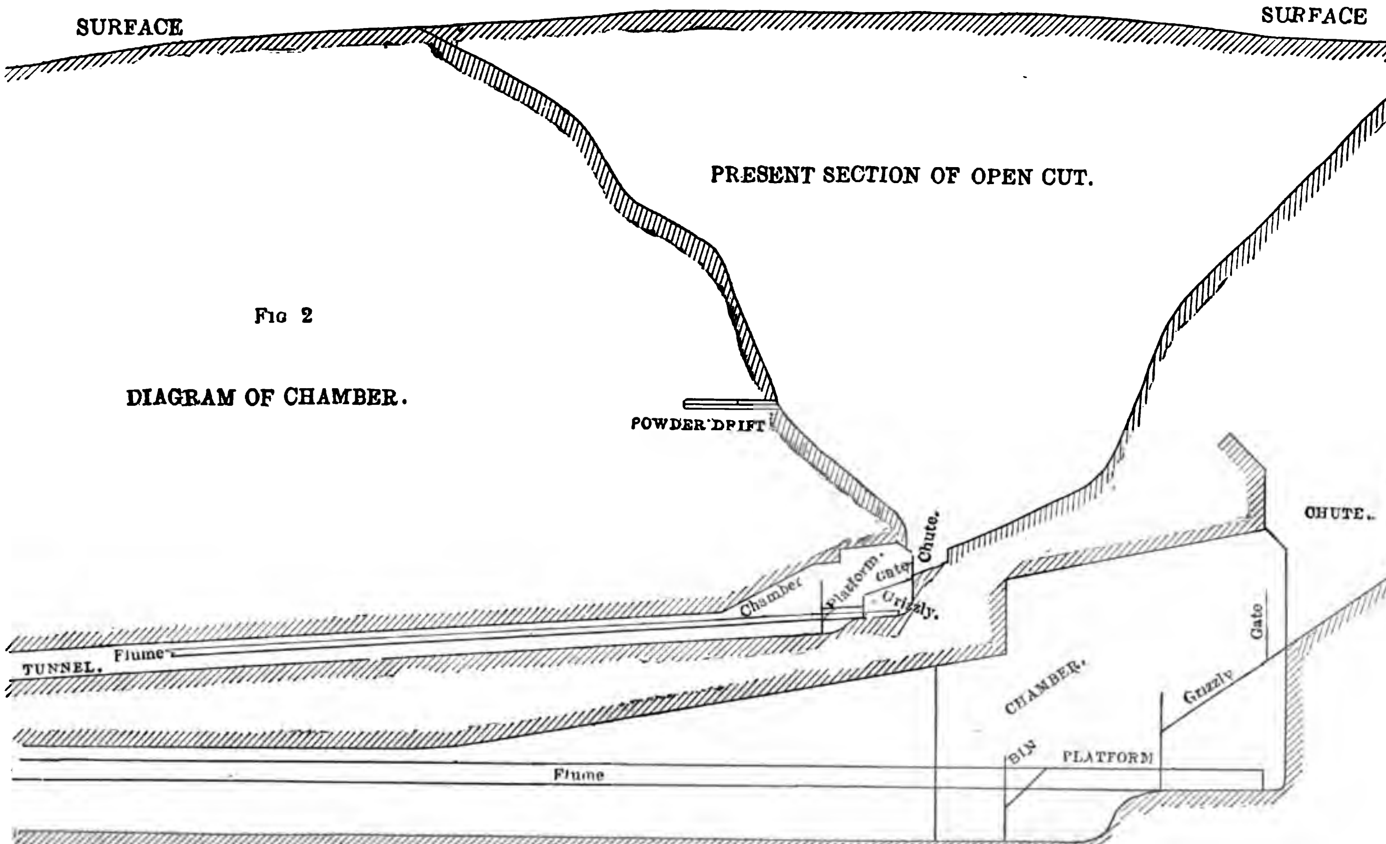


FIG 2

DIAGRAM OF CHAMBER.

bars of which are set 5 inches apart. The coarser material passes over the grizzly and on to the platform and bin below, from which it is loaded into cars and run out. What goes through the grizzly drops into a hopper below, from which it is fed into the flume.

This flume is 14 inches wide and 18 inches deep. It has a grade of 5 inches in 12 feet, and we run about 130 inches of water in it. This water carries all the material that comes into the flume out of the tunnel, and dumps it into a dump-box.

The dump-box is a large double compartment box, each compartment being 35 feet by 12, and 9 feet in the clear. It is provided with a large movable "tom-iron," and two hydraulic nozzles working under 90 feet pressure. The mine is worked on the day shift only, the quartz and dirt being run into one compartment of the box. The dump-box is run on the night shift, when the material that comes in by day is thoroughly washed free from clay, and is then run into another set of sluices, which convey the quartz direct to the mills.

At the mills the quartz-sand and dirty water are passed over a long grizzly of perforated screens. The quartz drops from this directly into the ore bins, and the sand and dirty water passes through the screens and is dropped into another flume. As the quartz goes into the mills it is also separated automatically as to size—the finer part going to the stamp mill, and the coarser to the concentrating mill. The waste water and sand that goes through the grizzlies is taken by the flume below to what is called the "plate house," where it is distributed over silvered plates.

We mine on week days only, running the mills every day. In every working day we mine about 300 tons of material. Of this about 10 per cent is run out in cars, and 90 per cent comes out in the flumes. This material is largely clay and sand, too fine to pay for further crushing. Three hundred tons of this dirt will produce 95 tons of milling quartz. This loose material—the sand and clay—all carries a considerable amount of fine loose gold, varying in size from the finer float gold up to particles the size of the head of a pin—we never find any coarser than this. This gold we save in the sluices and plate house. For this purpose we have the following arrangement of flumes, etc.: The flume from the chamber to the dump-box is 800 feet in length; grade, 5 inches in 12 feet; width, 14 inches, and is lined with block-riffles the entire way. The flume from the dump-box to mills is 300 feet long; grade, 6 inches in 12 feet; width, 24 inches, and is also lined with block-riffles. From the mills to the plate house the flume is 300 feet long; grade, 6 inches in 12 feet; width, 24 inches, and is lined with slat-riffles. These various flumes pick up about all the visible gold, so that the material that goes into the plate house is apparently nothing but sand and dirty water.

In the plate house this sand and water is divided into 6 equal parts, dropped into distributing boxes, and run over 6 aprons. These aprons are 20 feet long by 9 feet wide, with a grade of 5 inches in the 20 feet of length. Near the lower end each apron is covered with an apron of silvered plates, 9 feet square; below the silvered plates is a riffle filled with mercury, to catch loose amalgam, and below the aprons is a tank into which everything drops, to catch the loose mercury. All the water and sand is run over these aprons, each carrying about 20 inches of water. These aprons save the float gold that has escaped the sluices, and sometimes give astonishing results. We have cleaned up as high as 160 ounces of amalgam from them in a week. This gold is of the finest possible sort, and the amalgam has absolutely no grit, and is apparently almost a homogeneous

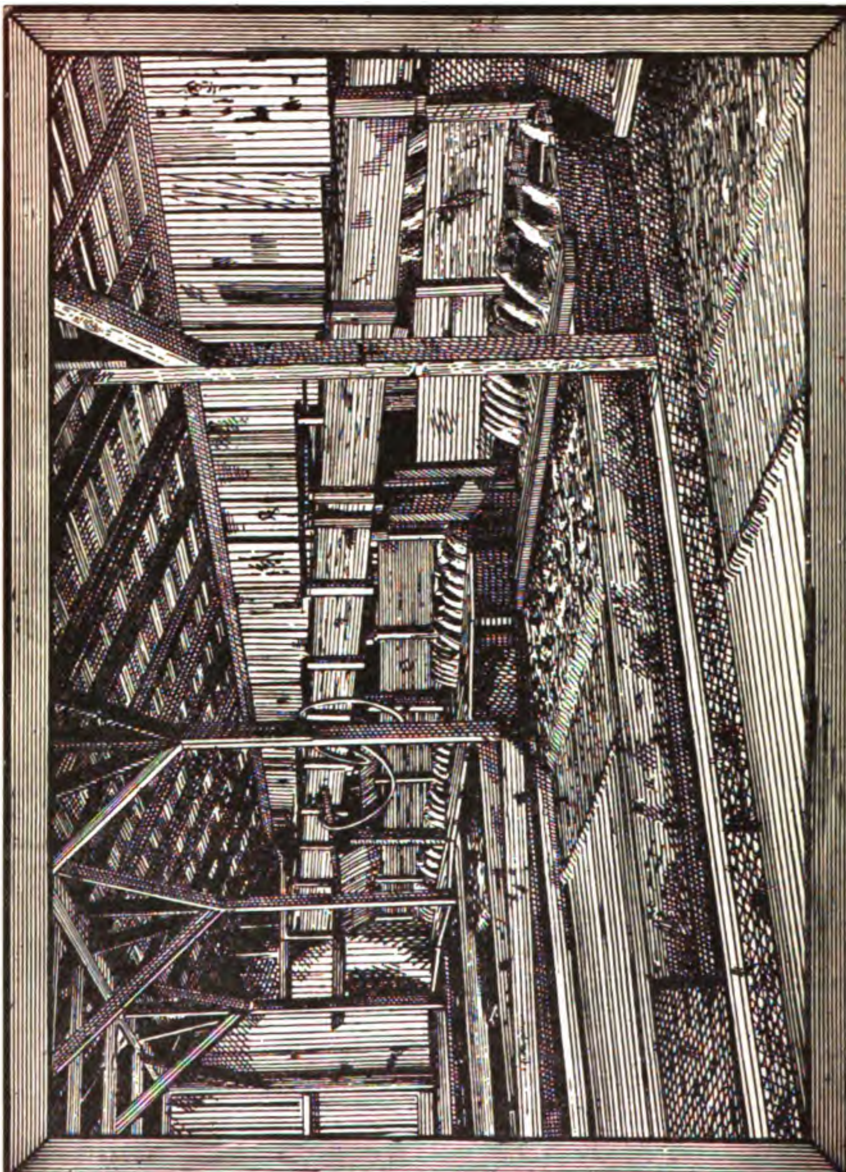


Plate House, Willard Mine.

mass of hardened mercury. The water, after leaving these plates, goes to waste, the plate house being the last gold-saving apparatus we employ.

At present we are working only the main vein. A great amount of work, however, has been done on the side veins, and a number of promising bodies of high grade ore have been developed. These side-vein ore bodies vary in length from 70 to 500 feet or more; the veins average in thickness

from 2 feet to 8 feet, and the walls are hard and firm. A large amount of ore has been taken from them near the surface and worked, and we are now preparing to open and work them at a depth.

We are running two mills—a stamp mill and a concentrating mill. The stamp mill is an ordinary mill of that sort. It contains 15 stamps, in 3 batteries of 5 each, with self-feeders, ore bins, and plates. We work all the fine part of the quartz here, so no rock breaker is required; and as the fine quartz carries little or no mineral, we have no concentrators here.

The stamps weigh 750 pounds each, work under a 6-inch to 8-inch drop, and drop 96 times a minute. We crush through a No. 5 slot screen, and crush $2\frac{6}{10}$ tons to the stamp in 24 hours.

We amalgamate entirely outside. For this purpose we have silver-plated aprons below the mortars, each apron being 4 feet 4 inches wide and 12 feet 6 inches long, with a grade of $1\frac{3}{8}$ inches to the foot. Below the aprons we have 12 feet of spout plates to each apron, 18 inches wide by 12 feet long, grade $\frac{3}{4}$ of an inch to the foot. The free gold in our rock, especially in the finer rock, is very fine flour gold. It is worth $18 50 an ounce, yet an ounce of dry, hard amalgam will only retort about one fifth gold. We have experimented with crushing through every size screen from No. 9 down to No. 4, and we find that although our gold is so very fine, yet we save the most per ton in crushing coarse through a No. 5 screen, and at the same time have a largely increased capacity over a fine screen.

The coarse rock and all the sulphur-bearing rock goes to the concentrating mill. This mill is constructed on a different principle from most mills of the sort, as we use Tustin pulverizers instead of stamps for crushing the quartz. The ore first goes through a 12-inch Blake rock breaker and then drops into the ore bin, from which it is fed to the Tustin pulverizers. These pulverizers are provided with automatic self-feeders, the same as we use in the stamp mill, and they feed the same way. We crush wet and amalgamate on aprons, after which the pulp is concentrated on Frue vanners.

We run four pulverizers. These run at 20 revolutions a minute, requiring 4-horse power each. We crush through a 20-mesh steel wire screen, the capacity of each machine being from 10 to 11 tons a day on the kind of rock that comes to it. The aprons are silvered plates, 4 feet wide by 10 feet long; grade, $1\frac{3}{8}$ inches to the foot. We use 8 Frue vanners, 2 to each pulverizer. Our coarse rock carries a very small per cent of sulphurets, from $\frac{1}{16}$ to $\frac{1}{4}$ of 1 per cent. The sulphurets, however, are very high grade, some being worth, when pure, upwards of $5,000 a ton. We concentrate our rock up to from 82 to 88 per cent of the assay value, according to the kind and grade of the rock.

A comparison of the two methods of crushing shows a marked difference in results. In crushing through the battery a large amount of slimes are produced. With the pulverizer a very small quantity of slimes is made. As a consequence, with our ore, where the rock is very hard, the gold exceedingly fine, and the sulphurets soft and brittle, we find that on the same ore we amalgamate a much greater percentage of the fine gold after the pulverizers than after the stamps; and when we come to concentrate, we can save only 18 to 20 per cent of the assay value of the ore after stamps, and 85 per cent after the pulverizers. On the same ore and with same screen our pulverizer is about the equivalent of 6 to 8 stamps, according to the character of the ore.

Our sulphurets we work ourselves, by roasting and chlorination. Our roasting works consist of two "Willard" furnaces, with all necessary appurtenances. These furnaces are of a ton capacity each to the charge, and

we can roast, if necessary, from 6 to 8 tons a day. The chlorination works are of equal capacity, consisting of 11 pairs of leaching and settling tanks, with generators, etc. We roast the sulphurets, granulate them, and run them in a car to the chlorination works. After which, they are treated in the usual manner, and the gold leached and precipitated.

We run entirely by water power. We use 130 inches in the mine. In the stamp mill we use, for power and amalgamating, 80 inches, under 140-foot head. In the concentrating mill we use, for power, amalgamating, and concentrating, 100 inches, under 160-foot head.

The cost of mining is about 50 cents per ton of quartz, delivered at mill. The average cost of milling in the two mills is about 60 cents a ton.

We employ 12 men altogether about the mine, including men in the open cut at the chamber and dump-box, and car men. In the mills we employ 7 men, and at the chlorination works 2 men, making a total of 21 men, on an average.

We have done no development work the past year, but are now putting up compressor, etc., for power drills, and propose soon to open up various veins at a depth.

Altitude, feet	2,200
Number of stamps	15
Weight of stamp, in pounds	750
Drop of stamps, in inches	6–8
Drop of stamps, per minute	96
Duty of stamp in 24 hours, tons crushed	$2\frac{8}{15}$
Size of screens, Slot No.	5
Number of Tustin mills	4
Revolution of Tustin mill, per minute	20
Duty of Tustin in 24 hours, tons crushed	10–11
Size of screen in Tustin, mesh	20
Miner's inches of water used in 24 hours in stamp mill	80
Miner's inches of water used in 24 hours in Tustin mills	100
Miner's inches of water used in 24 hours in mine	130
Pressure of water in stamp mill, in feet	140
Pressure of water in Tustin mill, in feet	160
Cost of mining, per ton	50 cents.
Cost of milling, per ton	60 cents.
Number of concentrators	8
Percentage of sulphurets	$\frac{1}{8}$
Number of men in mine	12
Number of men in mill	7
Total number of men employed	21

EL DORADO COUNTY.

The county is bounded on the north by Placer; on the east by Alpine County and the State of Nevada; on the south by Amador and Alpine Counties; and on the west by Placer and Sacramento. Geologically it differs but little from Amador, Calaveras, Tuolumne, and Mariposa Counties. The belts of limestone and granite and volcanic flows, form about the same prominent features within its boundaries as they do in the counties to the south through which passes the great auriferous lode. The county is celebrated for having sent forth to the world the first authentication of gold having been found in the State. Latterly renewed activity has been displayed in developing the mineral resources of the county, consequently many rich finds have been recorded.

SPRINGFIELD MINE.

This mine, formerly known as the Church Union, is the representative mine of the county; is situated at an altitude of 1,200 feet above sea level. The dimension of the claim is 4,500 feet on the lode; course of the vein is north and south; the dip about 80° to the east, and the average width about 3 feet. On the property is a 15-stamp water-power mill, using 110 inches of water, under a pressure of 450 feet, every 24 hours. Each stamp weighs 600 pounds, falls 9 inches, at the rate of 90 times per minute, and crushes 1¾ tons of ore per diem. The ore, free milling, containing about one per cent of sulphurets, is worked after the usual method of amalgamation in batteries and collection on outside plates. The sulphurets, after collection on Frue vanners, are worked by the chlorination process at the company's works, at a cost of $10 per ton.

Altitude, feet	1,200
Number of stamps	15
Weight of stamp, pounds	600
Drop of stamps, in inches	9
Drop of stamps, per minute	90
Duty of stamp in 24 hours, tons crushed	1¾
Miner's inches of water used in 24 hours	110
Pressure of water, in feet	450
Number of concentrators	3
Percentage of sulphurets	1
Value of sulphurets, per ton	$150 00
Cost, per ton, of working sulphurets	$10 00
Length of ore-shoot, in feet	800
Depth of shaft, in feet	1,400
Average width of vein, in feet	3

STUCKSLAGER QUARTZ MINE.

This mine, formerly known as the Sam. Sims, in Coloma Mining District, is noted as the first place in which the mineral roscoelite was found, and is worked solely as a pocket mine. A shaft has been sunk on an incline of 45° to connect with a tunnel 300 feet long. The claim is 1,500 feet long by 600 feet wide, and carries a five-foot vein; the hanging-wall is syenite, and the foot-wall is slate. The method of reduction and recovery is in the hand mortar and an arastra run by horse-power. The property was located in 1868, and from that date to the present time there have been several successive owners, all of whom have retired well recompensed.

FRESNO COUNTY.

ABBEY MINE.

This mine, owned by G. W. Grayson & Co., is situated in Fine Gold Mining District, in a formation of granite, at an altitude of 1,700 feet above the sea. The vein is about two feet in width; has an east and west course, and dips 22° to the north. The mine is worked through a shaft, which, on the incline, is 1,500 feet—reaching a perpendicular depth in the mine of 300 feet. The formation of the hanging-wall is granite, and of the foot-wall, syenite. The developments are three tunnels 200, 300, and 400 feet, respectively; a shaft 500 feet in depth, from which tunnels are run from the various levels on the vein, the longer of which is 300 feet easterly and 125 feet westerly on the vein.

The 10-stamp mill, hoisting works, and pumps are run by steam power. 80 per cent of the yield is obtained from the batteries, and 20 per cent from the outside plates. The plates are 4 feet in width, and 12 feet in length to each battery, inclining 1¼ inches to the foot.

Altitude, feet	1,700
Number of stamps	10
Drop of stamps, in inches	5
Weight of stamp, in pounds	800
Drop of stamps, per minute	96
Duty of stamp in 24 hours, tons crushed	2
Size of screens, slot	9
Depth of shaft on incline, in feet	1,500
Vertical depth, reach by shaft, in feet	300
Length of ore-shoot, as far as explored, in feet	500
Average width of vein, in feet	2
Cost of mining, per ton	$3 00
Cost of milling, per ton	$2 00
Percentage of recovery saved in batteries	80
Percentage of recovery collected on plates	20
Number of concentrators	4
Percentage of sulphurets	2½
Value of sulphurets, per ton	$225 00
Number of men in mine	30
Number of men in mill	5
Extra help about mine	15

NEVADA COUNTY.

This county, reputed to be the first in the State where quartz ledges were mined for gold, holds at the present time its prestige as one of the largest producers of the precious metal. The county is bounded on the north by Yuba and Sierra, on the south by Placer, and west by Yuba Counties, and on the east by the State of Nevada. The auriferous belt varies greatly in different sections of the county; some of the mines are in slates, some in granite, and others on the contact between granite and slate, the formation being granitoid rocks and metamorphic slates.

THE NORTH STAR MINE,

In Grass Valley Mining District, which lay idle for ten years, has been resuscitated, and is now in full operation; the owners have just incurred an expense of $80,000 for laying a pipe line, 20 inches in diameter, a distance of 2 miles, and a 40-stamp mill with all the latest attachments. The pipe will cross Wolf Creek, making considerable descent and ascent, and from the head of source to the point of discharge, will have a 250-foot fall. The capacity of the mill used at the present time is 20 stamps, and is run by water power; each stamp weighs 850 pounds, falls 7 inches at the rate of 90 times per minute, and crushes 2 tons of ore every 24 hours. The ore is that generally termed free milling, contains from 2 to 3 per cent of sulphurets composed of iron and copper pyrites, mispickel, galena, and zincblende. The sulphurets, having an assay value of $100 per ton, are saved by the Triumph concentrator and are treated by the chlorination process at a cost of $20 per ton. 80 per cent of the gold yield is recovered in the batteries and 15 per cent collected on the outside plates. The altitude is 2,400 feet above sea level, and the course of the vein is northwest and southeast, with a northerly dip of 26°.

Altitude, feet	2,400
Number of stamps	20
Weight of stamp, pounds	850
Drop of stamps, in inches	7
Drop of stamps, per minute	90
Duty of stamp in 24 hours, tons crushed	2
Percentage of recovery saved in batteries	80
Percentage of recovery saved on plates	20
Percentage of sulphurets	2-3
Value of sulphurets, per ton	$100 00
Cost, per ton, of working sulphurets	$20 00
Number of men in mine	150
Number of men in mill	—
Depth of shaft on incline, feet	1,500
Length of ore-shoot, feet	1,800
Average width of vein, feet	2
Number of concentrators	8
Cost of mining, per ton	$3 00
Cost of milling, per ton	$3 00

THE IDAHO MINE.

The Idaho Quartz Mine, in Grass Valley Mining District, paid, on the first Monday in August, its 202d monthly dividend. The first work done on the mine was a prospecting shaft, sunk on the south side of Wolf Creek, in 1864. No further developments were made until 1865, when the shaft was continued to a depth of 300 feet, from whence a drift to the westward opened into pay ore. The first dividend was paid in 1869, and, with but few exceptions, there have since been regular monthly payments. The yield of the mine, up to the present time, has been about $8,000,000, and the net profits, in dividends, to the owners, about $3,750,000. The shaft, reaching the 16th level, has a length of 2,200 feet on the incline, which is, vertically, a depth of 1,600 feet from the surface, and is being continued to reach a perpendicular depth of 1,700 feet. The ore-shoot—there being but one in the mine—is 1,200 feet in length, bearing to the eastward; in fact, all levels below the 7th have been run in that direction.

The claim is 3,100 feet, lineal, on the lode; course of the vein is north of east and south of west, dipping southerly about 65°; both foot and hanging-walls are classified as magnesian metamorphic rocks. There is a 35-stamp water-power mill on the property, each stamp having a weight of 850 pounds, falling 9 inches, dropping 72 times per minute, and crushing 2.85 tons of quartz every 24 hours. The ore is wet crushed, and when issuing from the batteries is conducted over blankets. The lighter particles are carried off by the force of the current, and the blanket savings are worked in the Attwood amalgamators, in which most of the gold is recovered. The skimmings are ground in the Knox pans. It is necessary that the blankets should be frequently washed; therefore, at intervals, the flow of the water and sand is turned from channel to channel, as the case requires, and the blanket over which the current no longer flows is taken up, and the savings washed into the tank preparatory to being fed to the amalgamator. The blanket is again relaid, the water and crushings are turned upon it, and the cleansing treatment is carried in a similar manner to the next blanket channel. Any gold that may escape the blankets is saved on the sluice plates, although the percentage so collected is not known. There is no amalgamation done in the batteries, nor any separate record kept of percentage saved by the different methods of recovery. The sulphurets, iron pyrites, and galena, $80 in value per ton are saved by the Cornish buddle and rocker, and are worked by the chlorination process at a cost of $20 per ton.

At the 1,000-foot level there are two 35 horse-power engines, run by com-

pressed air, which hoist the ore to the station, whence it is raised by water power to the surface. Formerly steam was the motive power, but since it has been substituted by water, the company saves an average of $30,000 per year.

Altitude, feet	2,500
Number of stamps	35
Weight of stamp, pounds	850
Drop of stamps, in inches	9
Drop of stamps, per minute	72
Duty of stamp in 24 hours, tons crushed	285
Size of screens, slot	5
Percentage of sulphurets	½
Value of sulphurets, per ton	$80 00
Cost per ton of working sulphurets	$20 00
Number of pans	4
Cost of mining and milling, per ton	$7 65
Number of men in mine	173
Number of men in mill	18
Number of men in and about mine	218
Vertical depth reached by shaft, about, in feet	1,700
Length of ore-shoot, feet	1,200
Average width of vein, feet	2½

THE EMPIRE MINE

Is in Grass Valley Mining District, about three fourths of a mile southeasterly from the Town of Grass Valley, and is one of the largest producers in the county. The dimension of the claim is 5,000 feet in length and 750 feet in width, being a consolidation of several mines. The altitude is 2,800 feet; course of the vein is north and south, with a westerly dip of 35°. The mill, of 40 stamps capacity, is run by water power; the stamps, weighing 850 pounds each, fall about 7 inches, at the rate of 95 times per minute, and crush 2 tons of ore every 24 hours. The number of miner's inches of water used is 80 inches in the mill, and 150 for hoisting works, pumps, and compressor. The water has a fall of 440 feet. So far there has been no adoption of style or size of screens, but a series of experiments are being conducted for the purpose of selecting the most suitable.

The developments made during the year comprise a shaft 150 feet deep and about 1,000 feet of drifts.

Of the yield of free gold, 80 per cent is saved in the batteries and 20 per cent is collected on the outside plates.

The sulphurets, iron pyrites containing a small amount of galena, varying in value from $120 to $300 per ton, are saved from the sluice tailings by the Triumph concentrator, of which there are 16 in the mill. The gold is extracted therefrom at a cost of $20 per ton, at custom works, by the chlorination process. The hanging-wall is diabase, but the formation of the foot-wall is as yet undetermined.

Altitude, feet	2,800
Number of stamps	40
Weight of stamp, pounds	850
Drop of stamps, in inches	7
Drop of stamps, per minute	95
Duty of stamp in 24 hours, tons crushed	2
Size of screens	Experimenting.
Miner's inches of water used in mill in 24 hours	80
Miner's inches of water used in hoisting works in 24 hours Miner's inches of water used in pump Miner's inches of water used in compressor	150
Pressure of water, in feet	440
Cost of mining, per ton	$3 00
Cost of milling, per ton	$0 75
Percentage of recovery saved in batteries	80

Percentage of recovery saved on plates	20
Number of concentrators	16
Percentage of sulphurets	2
Value of sulphurets, per ton	$120 00–300 00
Cost of working sulphurets, per ton	$20 00
Number of men in mine	150
Number of men in mill	8
Length of ore-shoot, feet, said to be	4,000
Average width of vein, feet	2½
Length of longest incline shaft, feet	1,600
Vertical depth reached by incline shaft, feet	600

PROVIDENCE MINE.

The mine is located on Deer Creek, 1¼ miles west of Nevada City, in Nevada City Mining District, at an altitude of 2,500 feet above sea level, in granite, contact and slate formation. Within the boundary lines of the patent are two distinct ledges running parallel to each other, each ledge averaging four feet in width. The veins have a north and south course, with an easterly dip.

In the Providence proper the shoots of ore throughout the mine vary in length from 50 feet to 400 feet, while in the Ural, or parallel ledges, the stopes are continuous, and average 250 feet in length. The Providence is opened, by one incline shaft, to a depth of 1,100 feet; the formation for 900 feet is granite, thence 900 feet of contact, followed by 1,800 feet of slate; both hanging and foot-walls change from granite to slate. There are eleven tunnels or drifts in the mine, the longest of which is 3,600 feet; in the latter the hanging-wall for the first 2,000 feet is granite; then giving way to slate, which continues the remainder of the distance; in the foot-wall the slate begins after 840 feet of granite.

The Ural vein is worked through a crosscut, 547 feet in length, run in a westerly direction, at the 600-foot level, in the foot-wall of the Providence mine. At the point where the crosscut intersected the Ural the vein is a contact, and so continues for a distance of 40 feet south, where both hanging and foot-walls become slate. The average width of the vein is 4 feet. A tunnel on the course of the ledge 584 feet in length is in quartz nearly the whole distance.

The following diagram will show the positions occupied by the Providence, Ural, and Wyoming Lodes. It will be seen that the Providence Lode and crosscut No. 1 are in granite; also, that the Ural Lode leaves the contact and runs into slate; also, a cross ledge running from the Ural into the Wyoming Lode.

The Providence Lode ran into slate on the 600-foot level, at a point 800 feet south of the incline shaft, and then became a contact vein.

Mr. Joseph Thomas, underground Superintendent of the Providence Mine, has for years, contrary to the opinions of many other persons, asserted that within the boundary lines of the company's property, to the west of the vein being worked, there existed a parallel ledge. Since he has proven the correctness of his opinion, he says that the Ural and Wyoming Lodes are parts of one and the same fissure, but that the former is lying on a big horse, and the cross ledge is running from the Ural to the Wyoming, and in going south the two will come together and form one lode.

The property has an area of 145 acres, and is in length 6,000 feet. The wet crushing 40-stamp mill uses 80 miner's inches of water every 24 hours; for pumping and hoisting 45 miner's inches are necessary, under a pressure of 380 feet. The stamps weigh 750 pounds each, fall from 6 to 8 inches, drop 93 times per minute, and crush, to the stamp, 2 tons of

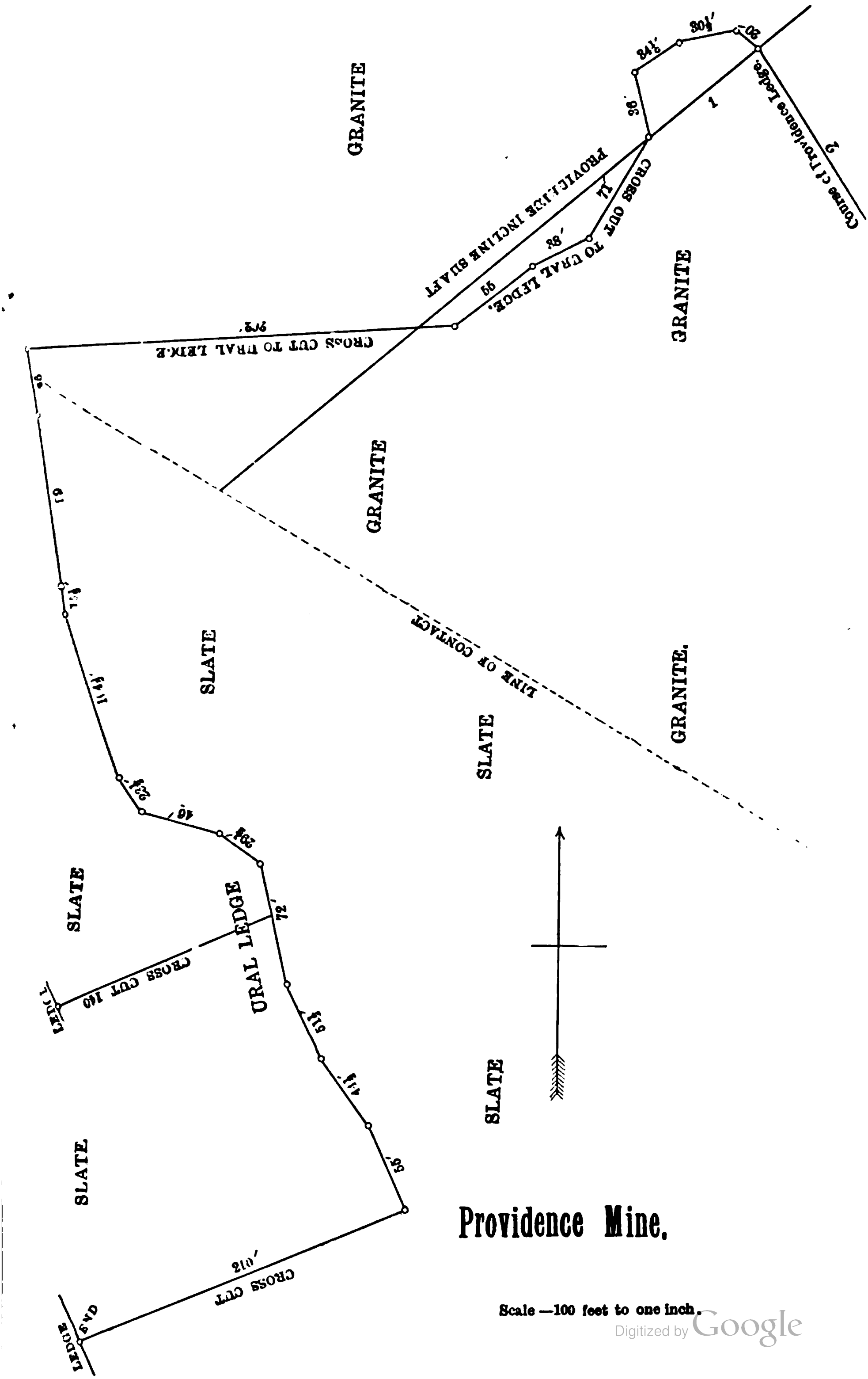
ore every 24 hours. The sulphurets, assaying $130 per ton, are saved by the Frue vanner, and are worked by the chlorination process at the company's works at a cost of $6 per ton. Of the gold obtained by amalgamation 20 per cent is from the batteries and 80 per cent from outside plates. The aprons and sluice plates are silver-plated, the former being 4 feet square and the latter 16 inches wide by 14 feet long to each battery, inclining 1¾ inches to the foot.

Altitude, feet	2,500
Number of stamps	40
Weight of stamp, pounds	750
Drop of stamps, in inches	6-8
Drop of stamps, per minute	93
Duty of stamp in 24 hours, tons crushed	2
Size of screens, round punched, No.	5
Miner's inches of water used in mill in 24 hours	80
Miner's inches of water used in hoisting and pumping	45
Pressure of water, in feet	380
Cost of mining, per ton	Not stated.
Cost of milling, per ton	Not stated.
Percentage of recovery saved in batteries	20
Percentage of recovery saved on plates	80
Value of sulphurets, per ton	$130 00
Cost per ton of working sulphurets	$6 00
Percentage of sulphurets	5-6
Number of concentrators	16
Number of men in mine	93
Number of men in mill	Not stated.
Number of men in and about mine	100
Length of ore-shoot in Ural, far as worked, feet	500
Length of ore-shoots, one after the other, entire distance worked in Providence, feet	250
Average width of veins, feet	4
Depth of shaft, feet (same shaft used for Ural at 600-foot level)	1,100

CONSOLIDATED WYOMING GOLD MINE.

This location was made in 1851, and has been, with but few slight intermissions, continuously worked since that time. The consolidation embraces the Ural Mine, on the ledge of the same name, of which mention is made under Providence. The company's property is situated in Nevada City Mining District, about 1¼ miles west of Nevada City, at an altitude of 2,400 feet above the level of the sea, in contact of slate and granite. Course of the vein is northwest and southeast, dipping 26° easterly. Hanging-wall of the Ural is granite, and the foot-wall slate, whereas, in the Wyoming, both walls are slate. There is a 16-stamp water power mill on the property, using 28 miner's inches of water every 24 hours, at a pressure of 396 feet. The weight of each stamp is 800 pounds, falling 7 inches, dropping 92 times per minute, and crushing 2 tons of ore per diem. The aprons are 52 inches wide, and the sluice plates, with an inclination of 1¾ inches to the foot, are 16 inches wide, by a length of 20 feet. The sulphurets are saved on the Frue concentrator, and are worked at custom works by the chlorination process. Steam power is used for hoisting and pumping. Forty per cent of the amalgable yield is recovered in the batteries, and 60 per cent is collected on the outside plates. Dimension of claim, Ural 2,000, and Wyoming 2,270, lineal feet.

Altitude, feet	2,400
Number of stamps	16
Weight of stamp, pounds	800
Drop of stamps, in inches	7
Drop of stamps, per minute	92
Duty of stamp in 24 hours, tons crushed	2
Miner's inches of water used in mill in 24 hours	28
Pressure of water, in feet	396



Providence Mine.

Scale—100 feet to one inch.

Cost of mining, per ton	$3 50
Cost of milling, per ton	$1 00
Percentage of recovery saved in batteries	40
Percentage of recovery saved on plates	60
Value of sulphurets, per ton	Not stated.
Percentage of sulphurets	2¾
Number of concentrators	8
Number of men in mine	30
Number of men in mill	5
Number of men otherwise engaged	5
Depth of shaft on incline, feet	900
Length of tunnel, feet	3,000

NEVADA CITY GOLD QUARTZ MINE.

Is in Nevada City Mining District, about one mile west of Nevada City, and at an altitude of 2,500 feet above sea level. The course of the vein is northerly and southerly—20° to 30° west of north and 20° to 30° east of south, dipping 33° to the east—the hanging-wall being granite and the foot-wall slate. The claim covers an area of 40 acres, and is 2,500 feet lineal on the vein. The mine is worked through two incline shafts 850 and 530 feet respectively, and is opened up by 8,000 feet of tunnels or levels. From the 850-foot incline, tunnels have been driven south, averaging in length 250 feet each, on the 1, 2, 3, 4, 5, 6, and 7th levels, and are connected with each other by stopes and upraises. On the same levels north tunnels, connected by upraises and stopes, aggregating 6,000 feet, have also been driven. At the 350-foot level there is a drain tunnel 1,600 feet in length, connecting with the 530-foot incline—at the depth of 300 feet on this incline there is a level run connecting with the stopes from the 850-foot incline.

All of the machinery is run by water-power, the water being conveyed to the property through an eleven-inch iron pipe, 3,200 feet in length, under a 300 foot pressure, at a cost of 16 cents for a miner's inch for 24 hours' use. Although the mill, of 20 stamps, is run by water-power, there is a steam-power plant in place to be used in case of an accident to the waterworks. At the mouth of each incline are hoisting and pumping plants which may be run by water or steam as circumstances require. The stamps weigh 750 pounds each, fall from 7 to 9 inches at the rate of 93 times per minute, and crush about 1¾ tons of ore every 24 hours. Apron and sluice plates are silver-plated, the former being in size 4 by 5 feet, and the latter with an inclination of 1¾ inches to the foot, are 14 inches wide by a length of 12 feet to the battery. There is no separate account kept of the difference between the battery and plate savings, but merely a record kept of the general clean-up. The sulphurets, iron pyrites with an admixture of sulphides of arsenic, zinc, and lead, in value about $100 per ton, are saved by the Frue vanner, and worked by the chlorination process at a cost of $20. The developments during the year consist of drifting and crosscutting from the 850-foot incline, on 500, 600, and 700-foot levels, and opening up shoots, and the sinking of an incline 530 feet to the ore body.

Altitude, feet	2,500
Number of stamps	20
Weight of stamp, pounds	750
Drop of stamps, in inches	7–9
Drop of stamps, per minute	93
Duty of stamp in 24 hours, tons crushed	1¾
Size of screens, round punched	5
Miner's inches of water used for all purposes, per diem	105
Pressure of water, in feet	300

Cost of mining, per ton	$2 50
Cost of milling, per ton	$1 00
Percentage of recovery saved in batteries	No record.
Percentage of recovery saved on plates	No record.
Value of sulphurets, per ton	$100 00
Cost per ton of working sulphurets	$20 00
Percentage of sulphurets	2–3
Number of concentrators	8
Number of men in mine, 25; boys, 7—total	32
Number of men in mill	6
Number of men in and about mine—all told	40
Length of ore-shoots, several, averaging in feet from	100–250
Average width of vein, feet	3
Depth of No. 1 shaft on incline, feet	850
Depth of No. 2 shaft on incline, feet	530

DELHI MINE.

(Contributed by E. H. GARTHWAITE, E.M.)

The mine is in Columbia Hill Mining District, near the town of San Juan, and has an altitude of 2,700 feet above sea level. The formation is metamorphic slate; the country rock is traversed by numerous dykes of diabasic rock. The course of the vein is north and south, with an easterly dip of 75°. Dimension of the claim is 1,500 feet in length by 600 feet in breadth. The improvements are an 8-stamp mill, wet crushing, and run by water power. Each stamp weighs 1,000 pounds, falls 6 inches at the rate of 94 times per minute, and crushes 3½ tons per diem. The plates are 46 inches wide, 36 feet long, and have an inclination of 80°. The formation of both hanging and foot-wall is slate. The nature of the sulphurets are iron, copper, and arsenical, and have a value of from $80 to $100 per ton, and are saved by the Triumph concentrator, but as yet they have not been worked. Every 24 hours there are 30 inches of water used, with a pressure of 200 feet. Shortly after the pay streak was struck in the main tunnel, another adit was started about 200 feet lower down the hillside. At the point where the adit was started there is no outcrop of the ledge, and by a miscalculation the starting point was in the hanging-wall. The error was increased by making the tunnel bear gradually to the east, instead of toward the west, so that when the tunnel had been advanced some 500 feet, the face was quite a distance in the hanging-wall from the ledge. Then the direction of the tunnel was changed; it bore westerly, and about 900 feet from the mouth cut the ledge, which was about 2½ feet wide and quite rich. The mine is very advantageously situated for deep exploitation, being located on the south side of the Middle Yuba, where the mountains are very precipitous, and the ledge can be opened up to a depth of at least 800 feet below its upper outcroppings by means of adit levels.

Altitude, feet	2,700
Number of stamps	8
Weight of stamp, pounds	1,000
Drop of stamps, in inches	6
Drop of stamps, per minute	94
Duty of stamp in 24 hours, tons crushed	3½
Size of screens, punched	5
Miner's inches of water used in 24 hours	30
Pressure of water, feet	200
Cost of mining, per ton	$2 00
Cost of milling, per ton	$0 60
Percentage of recovery saved in batteries	33–40
Percentage of recovery saved in plates	66
Number of concentrators	4
Percentage of sulphurets	½–3

Value of sulphurets, per ton	$80 00–100 00
Number of men in mine	8
Number of men in mill	3
Width of vein varies in feet from	3–18
Length of upper tunnel, feet	1,200
Length of lower tunnel, feet	600
Length of ore-shoot, feet	200

EAGLE BIRD MINE.

This mine is situated in Washington District, at an altitude of 3,700 feet above sea level, in slate and granite formation. The vein has a northerly and southerly course, dipping 67° to the eastward. The formation of the hanging-wall is slate, and that of the foot-wall is granite. The improvements on the property are, one 20-stamp mill run by water power, Blake crusher, air compressor, and hoisting works. The stamps weigh 750 pounds each, fall from 6 to 7 inches, and drop 95 times per minute, with a crushing capacity of 1½ tons of ore to the stamp every 24 hours. The plates, silver plated, have an inclination of 1¾ inches to the foot, are 4 feet wide, and 20 feet in length to each battery. Of the free-gold yield, the percentage saved in the batteries and collected on the outside plates is about equal. The dimension of the claim is 600 feet in width by 1,500 feet in length. Work was first commenced on the property by the sinking of a 400-foot shaft in 1873, since which time there have been five drifts run of 400, 250, 550, 350, and 175 feet in length, respectively.

Altitude, feet	3,700
Number of stamps	20
Weight of stamp, pounds	750
Drop of stamps, in inches	6–7
Drop of stamps, per minute	95
Duty of stamp in 24 hours, tons crushed	1½
Screens, brass wire, mesh	40
Miner's inches of water used in 24 hours	150
Pressure of water, in feet	175
Cost of mining, per ton	$2 50
Cost of milling, per ton	$0 55
Percentage of recovery saved in batteries	50
Percentage of recovery saved on plates	50
Percentage of sulphurets	¾–1
Value of sulphurets, per ton	$100 00
Average width of vein, feet	9
Depth of shaft, feet	400
Number of men in mine	24
Number of men in mill	5

SPANISH MINE,

Is a location about three miles north from the town of Washington, in Cherry Hill Mining District, and in altitude is 4,000 feet above sea level. The property consists of 11 claims, 600 feet by 1,500 feet each, course of the vein is north and south, dip 80° to the west, and both walls are slate inclosing a vein averaging 100 feet in width. The first work done on the claim was in April, 1885, but since then the following developments have been made: tunnel No. 1, 960 feet, tunnel No. 2, 100 feet; crosscuts, driven at intervals of about 200 feet, 860 feet; drifts on the ledge, 1,040 feet; prospect shafts, 5 in all, averaging 31 feet each; 3 upraises averaging 107 feet each. There are 4 Huntington mills, run by water power, at work on the ore, reducing in the aggregate 120 tons per day; two thirds of the gold yield is recovered by amalgamation in the mill, the remaining one third being collected on the outside plates. The plates, varying, are 4, 6, and 2 feet wide, with an inclination of 2 inches to the foot and 30 feet in

length to each mill. Water is the motive power, 55 miner's inches, under pressure of 250 feet, being used every 24 hours.

Altitude, feet	4,000
Number of mills, Huntington	4
Revolutions per minute	60
Duty of the mills in 24 hours, tons ground	120
Screens—homogenous steel, ¼ inch angle slot, No.	6
Miner's inches of water used in 24 hours	55
Pressure of water, in feet	250
Cost of mining, per ton	20 cents.
Cost of milling, per ton	40 cents.
Percentage of recovery saved in mill	75
Percentage of recovery saved on plates	25
Average width of vein, in feet	100
Number of men in mine, mining	5
Number of men in mine, prospecting	12
Number of men running mills	5
Length of No. 1 tunnel, in feet	960

SIERRA COUNTY,

One of the most rugged and mountainous counties in the State, is bounded on the north by Plumas, on the south by Nevada, and on the west by Yuba and Plumas Counties, the State of Nevada forming the eastern boundary.

The greater portion of the county is covered by eruptive conglomerates, underlying which are the auriferous slates, great masses of serpentine, and ancient gold-bearing gravel channels. As the greater part of the golden harvest of this county was recovered from the auriferous deposits of the ancient channels, the following interesting descriptions will be appropriate insertions:

The Great Blue Lead of Sierra County, by C. S. Capp, quoted in Hittell's "Handbook of Mining for the Pacific States." Mr. Capp writes:

This is not one of the many petty leads, an inch or two in breadth and thickness, which, after being traced a few hundred feet, end as suddenly and mysteriously as they commence; but it is, evidently, the bed of some ancient river. It is often hundreds of feet in width, and extends for miles and miles a thousand feet below the summits of high mountains, and entirely through them. Now it crops out where the deep channels of some of the rivers and ravines of the present day have cut it asunder; and, then, hidden beneath the rocks and strata above it, it only emerges again miles and miles away. Wherever its continuity has been destroyed, the river or gulch which has washed a portion of it away was found to be immensely rich for some distance below, and the materials of which the lead is composed are found with the gold in the bed of the stream. It is evidently the bed of some ancient stream, because it is walled in by steep banks of hard bedrock, precisely like the banks of rivers and ravines in which water now runs, and because it is composed of clay which is evidently a sedimentary deposit, and of pebbles and black and white quartz, which could only be rounded and polished as they are by the long continued action of swiftly running water. The bedrock in the bottom of this lead is worn into long, smooth channels, and also has its roughnesses and crevices like other river beds. The lighter and poorer qualities of gold are found nearer to its edges, while the heavier and finer portions have found their way to the deeper places, near the center. Trees and pieces of wood, more or less petrified and changed in their nature, which once floated in its waters, are also everywhere encountered throughout this stratum. The clay and finer gravel in which these pebbles and bowlders are found to be tightly packed, is of a light blue color, which gives the name to the lead. Much of this clay is remarkably fine and free from coarser particles, and is smooth and unctuous to the touch. It is said to be strongly impregnated with arsenic, as was shown by chemical analysis, and contains large quantities of iron and sulphur in solution, for pyrites and sulphurets of iron are deposited in shining metallic crystals in every vacant crevice. Fine gold is found among this clay, and the heavier particles beneath it, upon the bedrock. This stratum varies in thickness from eighteen inches to eight or ten feet, while the whole lead varies in width from a hundred and fifty to five hundred feet. The same lead has been found at Sebastopol, four miles above Monte Cristo, and also higher up among the mountains. It appears at Monte Cristo, which is four miles above the high-lying Downieville, and over three thousand feet above it, and at Chap-

arral Hill, on the side of a deep ravine; then, at the City of Six, which is also on very high land, about four miles from Downieville, across the North Yuba. It is next found at Forest City, on both sides of a creek, and is there traced directly through the mountain to Alleghany Town and Smith's Flat, on the opposite side. There it is again cut in twain by a deep ravine. It crops out on the other side at Chip's Flat, where it has been followed by tunnels passing completely through the mountain to Centerville and Minnesota on the other side. Here it is obliterated by the Middle Fork of the Yuba, but is believed to be again found at Snow Point, on the opposite side of the river; and again at Zion Hill, several miles beyond. There is no reason for doubting that after thus reaching over twenty miles, it still extends further. Hundreds of tunnels have been run in search of it. Where the line it follows was adhered to, they have always found it, and have been well rewarded for their labor. Millions of dollars have been taken from this lead, and its richness, even in portions longest worked, is yet undiminished. As in some of the claims quartz veins and poorer paying gravel have been found, many of them may be valuable to work from the top down, as hydraulic claims.

The theory that this blue lead was once the bed of an ancient stream, is generally accepted by those familiar with it. Another evidence to support the theory is, that in many places the flattish stones in the lead lie at a peculiar inclination, and all in the same direction, as stones do in a stream of water. This theory, however, does not find universal belief. Mr. B. P. Avery wrote thus of it for the San Juan *Press*, in 1859:

Everybody in California has heard or read of the famous "blue lead," which all miners who delve for gold far up in the mountains hope to find, and think themselves lucky when they have found it, and which they pronounce to be the channel of an ancient river. This lead is always found resting on or near the bedrock, beneath diluvial strata of different colors, such as shades of red, yellow, and gray, and is itself more of a deep slate color than blue. It is generally richer in auriferous particles than the gravel lying above it, and forms the productive drift diggings for which the vicinity of Forest City is noted, as well as those of many other localities. The theory of its origin alluded to above is predicated upon these facts and assumptions: that it has been traced in a continuous line, at a certain altitude, through several counties, from ridge to ridge, at a right angle to present watercourses, across cañons thousands of feet deep; that the stratification of the lead is uniform, and different from that of adjoining deposits; that tree trunks, both in the ligneous and petrified state, are found lying in it, as though borne there by freshets; and the gold found in it is everywhere of the same character as to appearance and quality. This crude theory conforms to the general one which is popularly employed to account for the extensive alluvial deposits constituting our placer diggings. It is remarkable that the majority of our miners, who are commonly men of intelligence and practical knowledge in their pursuit, should have discarded entirely, if they ever entertained, when speculating on the origin of our gold fields, the more rational theory of marine influence, for one of purely local causes. They overlook all the facts which go to prove a total submergence of this coast at some remote period, and settle down upon the narrow idea that the immense gravel beds which contain so large a portion of our mineral wealth, and which extend at least four hundred miles north and south, having an average breadth of probably not less than sixty miles, were deposited by rivers which anciently ran here, and changed their channels from time to time, until they paved the whole country with cobblestones. These deposits have been cut through by modern streams, running a different course, and hence the present cañons and ridges. Of the ancient rivers, the one that deposited the blue lead has alone left distinctive marks of its course. Now, unfortunately for the plausibility of this theory, the blue lead is found all the way from the summit of the Sierra Nevada to the foothills. Instead of being confined to a certain altitude, and a certain line, it exists in every altitude, on the main ridges as well as on spurs of them, and even on isolated peaks. Its color is owing to the presence of sulphuret of iron in solution, without which the gravel would not be any different from that lying above, except that the bowlders and large stones would be found in it, as they are always found at the bottom of every gravel deposit. Wherever sulphurous acid or sulphuret of iron is found, there the so called blue lead will be discovered, just as certainly as red earth and gravel will be found where the oxide of iron is present as a coloring agent. It is found at a great elevation in Sierra County, and at a low one in Nevada and Yuba. It has been struck at San Juan, and at points thirty or forty miles above it, leads of other colors intervening.

The "Dead Rivers of California," by John S. Hittell, quoted in "Raymond's American Mines and Mining." Mr. Hittell says:

A dead river is a channel formerly occupied by a running stream, but now filled up with earthy or rocky matter, and is not to be confounded with a channel that is open and remains dry during the greater part of the year because of a lack of water, or that has been abandoned by the stream for a deeper channel elsewhere. A dry river bed is *not* a dead river.

The dead rivers of California, so far as known, are on the western slopes of the Sierra Nevada, from 500 to 700 feet above the sea. They are all auriferous, and therefore they have been sought for and examined. They are not less interesting therefore to the miner than to the geologist; not less important to the statesman than to the antiquarian.

The largest dead river is known as "the Big Blue Lead," and has been traced from Little Grizzly, about latitude 39° 45′, in Sierra County, to Forest Hill, about latitude 38° 55′, in Placer County, a distance of 65 miles. The course is south-southeast, the position about 30 miles west of and parallel with the main divide of the Sierra Nevada. The elevation is 5,000 feet above the sea at Little Grizzly, and 2,800 at Forest Hill, showing an average fall of 33 feet per mile. The live rivers of the Sierra Nevada run at right angles to the course of the range, and have cut cañons from 1,500 to 3,000 feet deep, and they are separated by ridges which are from 3 to 6 miles apart, and are as high as the cañons are deep. The Blue Lead runs across these ridges from 200 to 1,000 feet below their summits. The traveler does not see any signs of a dead river in these ridges, which are as high and have the same general appearance at the Blue Lead as at other places. I shall presently tell how the miner discovers the lead, but before coming to that I want to give you a clear idea how the dead river crosses the ridges. Take a piece of common ruled cap paper; put your pen on a line, draw it up at an angle of 45° to the second line above, then down to first line at the same angle, and so on until the line made by your pen looks like eight rectangular saw-teeth, which are about an inch high. Consider those teeth as the ridges of the Sierra Nevada on the line of the Blue Lead in Sierra County, and the intervals between them as the cañons. Write over the first cañon to the left, Cañon Creek; over the next, Goodyear's Creek; and over the others consecutively, North Fork of the Yuba River, Rock Creek, Oregon Ravine, Wet Ravine, and Middle Yuba. Now draw a horizontal line across all the ridges a quarter of an inch from their tops. That line is the Blue Lead. The diagram, made as directed, represents a perpendicular section of the ridges and cañons of the Sierra Nevada, on the line of the Big Blue Lead in Sierra County, as seen from the west.

I have said that the traveler would see no sign of a dead river in riding over the country. The ridges are as high on its line as elsewhere; the cañon sides present the same appearance. Years elapsed before the miners discovered the existence of the ancient channel. But it required only a few months for the discovery that the live rivers were very rich in gold up to a certain point; that the abundance and size of the particles increased as they ascended up to that point; and that beyond or east of that point the streams were poor. Those points on the different streams were nearly in a line. Just there the ravines on the sides of the cañons were very rich, and they were comparatively poor elsewhere. The miners followed up the ravines, washing the dirt in their beds, and the dirt where the ravines were not too steep was a foot or two deep over the slate rock. At last, when the miners got near the top of the ridge, they found that the narrow shallow rock bed of the ravine suddenly disappeared, and the body of the hill was composed of gravel, which had a peculiar blue color, and part of it, a horizontal stratum about half a mile wide from east to west and five feet thick, was very rich in gold. They looked after the metal and paid little attention to anything else. As the stratum ran across the ridges from north to south, the miners followed it in with adits or tunnels, and in more than one place the tunnels met; and a few years ago it was customary for footmen passing between Monticello and Excelsior to go underground a distance of a mile rather than to climb over the hill six hundred feet high, by a path nearly two miles long. In the same manner Forest City and Alleghany were connected by a continuous tunnel; but the timbers have rotted, the roof has fallen in, and the passage is now closed.

The auriferous deposit is gravel, mixed with bowlders, clay, and sand, varying from a hundred to three hundred feet in depth; in strata distinguished from one another by differences in color, in the size of the bowlders and gravel, and in the number and size of the particles of gold. The predominant color is bluish-gray, dark at the bottom, and lighter above, with a reddish tinge in those places that have long been exposed to the air, showing the presence of iron. The material of the bowlders, gravel, and sand, is almost exclusively quartz. In the whole length of the river, as traced for a distance of sixty-five miles, assuming that the deposits of gravel average half a mile wide and two hundred feet deep, there were, counting in the portions which have been washed away by the live rivers, six billion six hundred and sixty million cubic yards of quartz and clay, and the quartz alone must have measured five billion cubic yards. In the live rivers quartz forms only a small portion of the gravel. Whence came all the quartz of the Big Blue? How did it happen that no granite, slate, porphyry, basalt, or sandstone was buried in this bed? If all the quartz veins now known in California were cleaned out to a depth of one hundred feet, they would not supply so much as is found in sixty-five miles of a river, that must have run for many hundreds of miles. The gravel is all water-worn, and rounded by long attrition. It came from far north. A piece of rough quartz, while being carried five hundred miles in the fiercest of our mountain streams, would not be worn so smooth as is every pebble in the Blue Lead. And the immense size of the bowlders implies a mighty current. Those in the lowest stratum average, in some places, a ton, and many are found of twenty tons. These are worn as smooth as the pebbles. They are not found scattered here and there, as though they had tumbled down from the banks of the river near to the spot where they are found; but they are evenly distributed in a stratum of equal thickness, across the whole bed, and for miles in length. Above that may be a stratum of bowlders of half the size, and then another stratum of larger ones. The great river handled these masses of rock with as much apparent ease, and spread them out as evenly, as if they had been no larger than pigeons' eggs.

The particles of gold are larger in size, and contain more silver at the bottom than at the top. The smaller pieces are in the upper strata, and as they have a larger surface proportionately, the silver is eaten out by the sulphurous acid which is developed in the gravel by the oxidation of pyrites. If a double eagle and twenty one-dollar pieces are thrown into a solution of vitriol, and left there for several weeks, the small pieces will, at the end of that time, contain a larger proportion of gold than the large one; and, for a similar reason, the surface placer gold is finer, chemically, than that obtained from the deeper strata. As a general rule the deep gold is 900 fine, or is worth $18 60 per ounce, and the surface gold is 920 fine, and is worth $19 per ounce, in the Big Blue Lead. The gold and gravel are deposited as in live rivers. There are banks, bars, eddies, ripples, rapids, and falls. There is little gold in the rapids and much in the eddies. The richest places have contained as much as fifty dollars to the cubic yard of the lower stratum; or, if the large bowlders were left out of the estimate, to two or three cubic feet. The space between the bowlders is filled with sand, clay, and gravel, which contains the gold. In the upper strata there are from fifty cents to two dollars to the cubic yard. The bed is of slate rock, and the banks are from fifty to three hundred feet high; but there are few places where they have been examined, for nowhere has all the gravel been washed away across the channel.

But how was it possible that the bed of a large river could be filled three hundred feet deep with gravel? When the miners in 1850, 1851, and 1852, flumed the live rivers of California, and took the gold from their beds, they found a deposit of gravel that did not average more than five feet deep on the bedrock, in streams that ran in cañons one thousand feet deep; and it is strange that the Big Blue should have filled its bed with gravel. Yet this filling up is not without an analogue in our day. Under the influence of hydraulic washing, Bear River and Yuba River have, within the last fifteen years, begun to fill up with gravel, and their beds have, for miles, risen seventy feet or more above the levels of 1853. This gravel is auriferous, and it is deposited in strata, and the arrangement and general appearance resemble those of the Big Blue Lead. The filling up began down in the valley, and as it ascended the current became less rapid, and lost the power to carry away the gravel. In Bear River, below Dutch Flat, the bed rises two feet per month during the chief washing season, from February to September, and in the remaining four months it falls on account of the stoppage of washing, and of the winter floods which carry away perhaps half of the accumulation of the summer. Some persons claim that various camps on parts of dead rivers in Plumas County are on the Big Blue Lead, and others think that portions of a dead river, near Placerville, belong to the same stream. I do not accept these theories, but if they are true, the Big Blue River has been traced about one hundred and ten miles. In the northern part of Plumas County the river is buried under deep beds of lava and basalt, and south of Placerville it is probably below the level of the live streams, and thus cannot be found by any system of mining or mode of prospecting now in use. Even in places where it is above the level of the live streams it may be covered on the sides of the cañons by slides of rock or of barren dirt or gravel, and the miner might spend thousands of dollars in a vain search for treasures not ten feet from his drift, as many have done, and some accident, luck, or perseverance afterwards proved the proximity of the rich deposit. In several cases the lead was found by calculation. The miner took his position on a hillside, on a line and on a level with other mining camps, and in a few days he found a fortune; and others have spent years working on a similar plan without success. The river must have taken bends on the north side of Rock Creek and Oregon Ravine, and twelve years of searching have not revealed the position of the bends. But why did the Big Blue River die, and leave nothing but its gravel and its gold to tell the story of its existence and of its greatness? The main cause must have been the subsequent rise of the Sierra Nevada. Suppose that a range of mountains, seven thousand feet high, were upheaved thirty miles east of the Mississippi; that the bed of that stream were on the mountain side three thousand feet above the sea, and that thirty miles west the country retained its present level; the result would be that the present Mississippi would soon be a dead river; it would be cut across by streams running down the mountain side, and pouring into a new Mississippi, thirty miles or more west of the present one. We know that the Sierra Nevada has been upheaved; that a large stream ran on what is now the mountain side, and that it has been succeeded by a new river farther west, and we must infer that the death of the old and the birth of the new river were caused by the upheaval.

Many of the hills crossed by the Big Blue are capped with lava and basalt, which covered much of the country from near the summit of the range to about three thousand feet above the sea. It seems then that the river filled its bed with gravel; the mountains began to rise, and volcanoes broke out along the divide; the lava ran down and covered the land to the line of the dead river and beyond it; the mountains rose still higher, and the waters running down their sides cut through the lava and made deep cañons, and washed away two thirds or three fourths of the dead river, and scattered its gold among the living waters. The descent of thirty-three feet per mile observed between Little Grizzly and Forest Hill would make a terrific current in a stream half a mile wide. The Sacramento is a lively river, yet its grade is only five feet in a mile. But no ordinary current could have carried the large quartz bowlders of the Big Blue Lead from distant regions and distributed them evenly over the river bed. It is possible, however, that in the lifting up of the mountains the relative elevations have been altered, and that the present grade differs from that of the Big Blue while it was alive.

A question suggests itself whether the great dead river was the predecessor of any live

stream; but to this no satisfactory answer can now be given, and it is doubtful whether time and research will ever furnish one. The Big Blue was parallel to the Sacramento, and has, to a certain extent, been succeeded by it; but it drained a much larger district than the Sacramento does, or the rainfall of the country was much greater in the era of its exisence. The Sacramento does not carry one fourth of the water which ran in the Big Blue—probably not one tenth. If we could ascertain that the quantity of rain had not altered, then we would be justified in presuming that the Columbia River, which would about fill the bed of the Big Blue, instead of turning westward at Walla Walla, originally continued southward, until the lifting up of Shasta and Lassen, and the adjacent ridges, stopped its course and compelled it to break through the Cascade Range at the Dalles. With our present limited knowledge we are not justified in calling the Big Blue River either the Dead Sacramento or the Dead Columbia.

Some persons have argued that the Big Blue Lead was never a river, but only a lacustrine or alluvial deposit. This theory, however, is untenable. The Big Blue Lead has all the marks which a dead river should have. It has a long course, a width nearly uniform, a course nearly straight, some bends with eddies on the inner side, a peculiar quartz, unlike any found in the neighboring ridges, or in the streams to the eastward, and abundance of quartz which no place now known to us could have supplied, and which came, probably, from a distant northern region, now covered with lava; water-worn gravel, which must have been carried far; flat stones, pointing down stream, as a current would place them; strata of coarse and fine gravel, which must have been deposited in a stream; a uniform descending grade: the coarse particles of gold, which could not have been distributed so evenly over a wide channel, except in a strong current; an immense quantity of gold, which required ages to scatter through a deposit three hundred feet deep; driftwood, unmistakably water-worn; trunks of trees, with the butts up stream; tributary brooks, and a number of other evidences, which would require more space for their description and explanation than I could spare. To say that the Big Blue is not a dead river is equivalent to saying that the bones of the mastodon never belonged to a living animal, but were formed under geological influences exclusively.

If this were the only dead river in the State, the proof would be less conclusive; but there are a dozen others. One, which runs southwestwardly, and may be called the Dead Brandy River, appears at La Porte, Brandy City, Camptonville, and North San Juan, and is marked by the same general characteristics, save that the gravel is finer, the pebbles in the upper strata being generally not larger than a pigeon's egg.

In Tuolumne and Calaveras Counties we have the Dead Stanislaus, or Tuolumne Table Mountain, which runs from near Silver Mountain, in Alpine, to Knight's Ferry, and there disappears. It is covered by a bed of basalt, which flowed as lava from a volcano and filled up the ancient bed; and this basalt has resisted the wear of the elements, and now stands as a mountain forty miles long, a quarter of a mile wide, and eight hundred feet high, the softer adjacent slate rock having been wasted and washed away. Under this mountain lies a dead river rich in gold. A similar table mountain of basalt, covering an auriferous dead river, which I call the Dead Cherokee, after its chief mining camp, extends seventy miles from Lassen's Peak to Oroville. At Bangor, in Butte County, is a small dead river, seventy feet below the general surface of the ground, and covered with ordinary soil and gravel. There are also dead rivers at Smartsville, Mokelumne Hill, and San Andreas. The Big Blue and the Dead Brandy are distinguished by the depth of their gravel and by the absence of pebbles of eruptive origin in it; and others have either short courses or shallow deposits of gravel; and the quartz forms a much smaller percentage of the gravel. In the dead rivers at Cherokee, Bangor, and Smartsville, a large proportion of the bowlders and pebbles is of lava and basalt, as if the streams had been formed after the commencement of the volcanic era. But different as is the material of the gravel, the fluvial origin of the deposits is similar and indubitable in all of them, when they are studied together.

SIERRA BUTTES MINE.

This property, in the Sierra City Mining District, is situated on the southern slope of the Sierra Buttes Mountain, whose peaks rise 4,700 feet above the lower works, and 8,800 feet above sea level. The altitude of the croppings is 6,400 feet, and that of the lower tunnel is 4,100 feet. The dimension of the claim is 11,000 feet in length by 600 feet in width; the vein has a general east and west direction, with a dip to the north of 41°, and averaging in width 20 feet. Work was first begun on the mine in 1850, and has been unremitting in dividends up to the present date. There are two water-power wet-crushing mills on the property, of 50 and 60 stamps, respectively; but only one, that of 60 stamps, is being used at present. The stamps weigh 850 pounds, fall 8 inches, strike 86 times per minute, and each stamp crushes 2½ tons of ore every 24 hours. The water supply, drawn from several lakes, is brought around the mountain-side, a distance of 7½ miles, in flumes to the mine. The main flume, 7

miles in length, is fed by several tributaries, which tap the sources of supply. The sulphurets are collected on the Frue vanner, and are treated at the company's works by the chlorination process. The property is now, and has been since 1870, owned and worked by an English company. The mine is worked through a series of nine tunnels.

Altitude of croppings, feet	6,400
Altitude of lower tunnel, No. 9, feet	4,100
Number of stamps working	60
Weight of stamp, in pounds	850
Drop of stamps, in inches	8
Drop of stamps, per minute	86
Duty of stamp in 24 hours, tons crushed	$2\frac{1}{8}$
Size of screens, slot	7
Width of apron plates, in feet	4
Width of sluice plates, in inches	15
Total length of plates, in feet	240
Number of concentrators	24
Miner's inches of water used	320
Pressure of water varies, in feet	60–620
Cost of mining, including dead work, per ton	$3 98
Cost of milling, per ton	$0 37$\frac{3}{4}$
Percentage of recovery saved in batteries	73
Percentage of recovery saved on plates	27
Percentage of sulphurets	$\frac{1}{3}$
Value of sulphurets, variable, per ton	$90 00–550 00
Cost per ton of treating sulphurets	$16 40
Average width of vein, in feet	20
Number of men in mine	210
Number of men in mill	10
Total number of men employed	290
Length of ore-shoots:	
Willoughby, feet	250
Tinney, feet	70
Bonanza, feet	210
Mammoth, feet	800
Length of No. 6 tunnel, in feet	4,850
Length of No. 7 tunnel, in feet	5,050
Length of No. 8 tunnel, in feet	5,200
Length of No. 9 tunnel, in feet	7,200

THE YOUNG AMERICA CONSOLIDATED MINING COMPANY.

The company's property is in Sierra City Mining District, about seven miles north of Sierra City, and has an altitude of 7,400 feet above the sea. The consolidation is 6,000 feet in length by 500 feet wide. The vein has an easterly and westerly course, a northerly dip of 45°, and averages $5\frac{1}{2}$ feet in width. The formation of the hanging-wall is diabase, the same in character as that which formed the hanging-wall of the rich auriferous shoot in the Eureka Mine at Grass Valley; also identical with the rocks forming the walls of the richest mines in Venezuela.

The mill occupies a site 3,200 feet from the mine—in this distance the perpendicular height of the mine above the mill is 900 feet. The ore is conveyed to the mill by an elevated tramway in buckets of 100 pounds capacity. At present it requires the work of two men to fill the buckets in transit, but that duty will soon be performed automatically by an invention of Mr. Busch, the foreman of the mine. The consolidation contains within its environs four lakes—the smaller one, three fourths of a mile below the mill, is used to impound the tailings; the higher one, directly under the snow-capped Buttes, feeds the waters of the melting snow to the reservoir, which furnishes the mill with power. The gross proceeds of the mine and mill, for the year ending August 15, 1886, amounted to $294,000. For the first three months of the year there were but ten stamps, then ten more were added, making a crushing capacity of

20 stamps up to July 6, 1886; then an additional ten were put in place, and lastly, on August 18, forty stamps were dropping on the quartz of the mine. Owing to the favorable location, this mine can be opened by tunnels to a depth of about 1,600 feet. During the year the company has built a dam, separating the two larger lakes, 175 feet long, 25 feet high, and 52 feet at the base, at a cost of $8,000.

Altitude, feet	7,400
Number of stamps	40
Weight of stamp, in pounds	750
Drop of stamps, in inches	7
Drop of stamps, per minute	80
Duty of stamp in 24 hours, tons crushed	2
Average width of vein, in feet	5¼
Size of screens, slot	7
Width of apron plates, in inches	48
Width of sluice plates, in inches	15
Total length of plates, in feet	800
Miner's inches of water used, per diem	30
Pressure of water, in feet	230
Cost of mining, per ton	$2 00
Cost of milling, per ton	$0 75
Percentage of recovery saved in batteries	95
Percentage of recovery saved on plates	5
Number of men in mine	50
Number of men in mill	8
Total number of men employed	90
Length of No. 1 tunnel, in feet	960
Length of No. 2 tunnel, in feet	1,160
Length of No. 3 tunnel, in feet	75
Depth of shaft on incline to No. 2 tunnel, feet	606
Length of ore-shoot, so far as explored, in feet	625

ALASKA MINE,

Is located at Pike City, at an altitude of 3,800 feet above sea level, and is one of the most prosperous mines in the county. The course of the vein is northeast and southwest, averaging 3 feet in width, with nearly a vertical dip. The claim is 4,200 feet, linear measurement, and is worked through a shaft 457 feet in depth. Levels are run at a depth of every 100 feet, the two longest being 2,000 feet each in length, and are still being extended. The developments made during the year are 1,500 feet of levels and 300 feet of upraises. Formation of the foot-wall is slate, and of the hanging-wall, slate and porphyry. The mill is 40-stamp, run by steam. Each stamp weighs 850 pounds, falls 7 inches at the rate of 86 times per minute, and crushes 2¼ tons every 24 hours. The apron plates are 30 by 52 inches, sluice plates 24 inches wide by 14 feet in length to each battery, pitching 1¼ inches to the foot.

The sulphurets are principally iron pyrites, but not of sufficient value to save; 65 per cent of the yield is saved in the batteries, and 35 per cent is collected on the outside plates.

Altitude, feet	3,800
Number of stamps	40
Weight of stamp, in pounds	850
Drop of stamps, in inches	7
Drop of stamps, per minute	86
Duty of stamp in 24 hours, tons crushed	2¼
Size of screens	No. 6
Cost of mining, per ton	$3 50
Cost of milling, per ton	$0 75
Percentage of recovery saved in batteries	65
Percentage of recovery saved on plates	35
Number of men in mine	70

Number of men in mill	9
Total number of men employed in and about mine	100
Vertical depth of shaft, in feet	457
Average width of vein, in feet	3
Length of ore-shoot, in feet	2,000

TUOLUMNE COUNTY.

KELTZ GOLD QUARTZ MINE.

This property, occupying an altitude of 2,000 feet above sea level, in Tuolumne Mining District, is in a slate formation, of which both walls have the same character. The claim has an area of 1,500 feet by 600 feet; and the course of the vein is northeast and southwest, with an easterly dip from 30–40 degrees, and is about 2 feet wide. The ore is reduced in a 10-stamp water power mill, and 85 per cent of the gold recovery is saved in the batteries, whilst 15 per cent is collected on the outside plates. The sulphurets, averaging in value $200 per ton, are saved by the Cornish buddle; but the cost of extracting the gold is not yet known, as the concentrations are, for the present, held in reserve. The outside plates, two to each battery, are 14 inches wide by a total length of 48 feet, and an inclination of 1 inch in 14 inches.

Altitude, feet	2,000
Number of stamps	10
Weight of stamp, pounds	650
Drop of stamps, in inches	6
Drop of stamps, per minute	85
Duty of stamp in 24 hours, tons crushed	1
Size of screen, slot No.	9
Miner's inches of water used in mill in 24 hours	12
Pressure of water, in feet	500
Cost of mining, per ton	Not given.
Cost of milling, per ton	$0 75
Percentage of recovery saved in batteries	85
Percentage of recovery saved on outside plates	15
Percentage of sulphurets	2
Value of sulphurets, per ton	$200 00
Number of concentrators	1
Number of men in mine	12
Number of men in mill	2
Average width of vein, in feet	2
Length of ore-shoot, in feet	400
Length of adit level, in feet	355
Depth of shaft, in feet	300

SOULSBY GOLD QUARTZ MINE.

The mine is situated in Tuolumne Mining District, at an altitude of 2,880 feet above the level of the sea, in a granite formation, both walls being of the same. The claim is 3,200 feet, linear measurement. The course of the vein is north and south and almost vertical, but at times dipping slightly to the east, and is 12 inches wide. The percentage of sulphurets is very variable, sometimes reaching as much as 20 per cent, although the assay value seldom changes from about $50 per ton. The method of saving the sulphurets is in the Morris canvas-covered sluices, after which they are worked for the gold by pan amalgamation. The cost of extraction and the percentage recovered are not given.

The batteries save 90 per cent and the outside plates 10 per cent of the yield of free gold. For the collection of gold on the outside there is a double run of electro-silvered copper plates, 16 inches wide, with a total length of 32 feet and an inclination of 1 inch in 14.

Altitude, feet	2,880
Number of stamps	15
Weight of stamp, in pounds	750
Drop of stamps, in inches	6
Drop of stamps, per minute	85
Duty of stamp in 24 hours, tons crushed	1
Size of screen, brass wire	60
Miner's inches of water used in mill in 24 hours	50
Pressure of water, in feet	350
Cost of mining, per ton	Not given.
Cost of milling, per ton	$0 75
Percentage of recovery saved in batteries	90
Percentage of recovery saved on plates	10
Number of men in mine	30
Number of men in mill	3
Average width of vein, in feet	1
Depth attained by deepest shaft, in feet	730

THE BUCHANAN MINE.

The property consists of a consolidation of four claims, each 600 feet wide by a length of 1,500 feet. Both walls are schist, but at the lower level the hanging wall is a dyke—probably a diorite. The course of the vein is north, 70° east, and dips from 53° to 64° northeast; the average width being about 5 feet. The mine is worked to a depth of 500 feet, through an almost vertical shaft. The mill, containing 20 stamps, is run by steam power; the stamps weigh 850 pounds each, have a fall of from 7 to 7½ inches 90 times a minute, and crush, each, 2 tons of ore every 24 hours. Two of the batteries contain inside plates, where two thirds of the gold yield is recovered from the 10 stamps; the other 2 batteries do not contain inside plates. Of the outside plates the upper ones are 4 feet wide by 6 feet long, with an inclination of 5°, and are made of soft copper. The lower plates are 3 feet 8 inches wide, and, together with the upper plates, form a total length, to each battery, of 10 feet 11 inches, with an inclination of 6°. Seven inches below the lower end of the plates, are movable soft copper-lined boxes, 7 inches wide by 20 inches in length, and 1 inch deep. Following are troughs, inclining 5°, with silvered plates, 18 inches wide by a length of 16½ feet. The pulp on leaving the plates flows into the movable boxes, and thence into the sluices. Between the upper and lower plates there is a wooden space, 2½ inches wide.

Number of stamps	20
Weight of stamp, in pounds	850
Drop of stamps, in inches	7-7½
Drop of stamps, per minute	90
Duty of stamp in 24 hours, tons crushed	2
Size of screens, No.	8
Percentage of recovery saved in batteries	⅔
Percentage of recovery saved on outside plates	⅓
Percentage of sulphurets	1
Value of sulphurets per ton,	$120 00—$260 00
Number of concentrators, Frue	8
Number of men in mine	9-15
Number of men in mill	7
Length of ore-shoot, in feet	200
Depth of shaft, in feet	500

TABULAR STATEMENT OF MILLS.

Name and Locality of Mill.	Water or Steam Power	No. of Stamps	Weight of each Stamp, pounds	Drop of Stamps in Inches	Drop of Stamps per Minute	Number of Tons Crushed per Stamp in 24 hours	Number of Screens.
Amador County.							
Plymouth Consolidated.	Water	80	750	7	90–100	Av. 2	
Plymouth Consolidated.	Water	40	1,000	7	90–100		
Keystone	Water	40	750	7–$8\frac{1}{2}$	96	$2\frac{1}{2}$	8 slot.
South Spring Hill	Water	20	750	6–7	90	$2\frac{1}{2}$	7 slot.
Stewart	Water	40	850	7	85	$4\frac{1}{2}$	6 slot.
Moore	Water	10	850	7	90	3	6 slot.
Downs	Water	20	600	8	85	$1\frac{1}{4}$	9 and 10 slot.
Mammoth Tunnel	Water	10	750	8	90	$2\frac{1}{2}$	6 slot.
Zeile	Water	40	750	$7\frac{1}{2}$	87–88	$3\frac{37}{100}$	4 slot.
Calaveras County.							
Stickles	Water	20	900	7	80	$3\frac{3}{4}$	9 slot.
Utica	Water	20	950	8–9	80	3	9 slot.
Deep Lead	Water	8	750	9	85–87	Carloads, 5	5 mesh.
Sheep Ranch	Steam	30	800	8	85	$2\frac{1}{4}$	9 slot.
Fine Gold	Water	10	750	6	100	$2\frac{1}{10}$	40 mesh.
Oro Plata, stamps	Water	15	750	6–8	96	$2\frac{6}{10}$	5 slot.
Oro Plata, Tustin Mill*	Water						20 mesh.
El Dorado County.							
Springfield	Water	15	600	9	90	$1\frac{3}{4}$	
Fresno County.							
Abbey	Steam	10	800	5	96	2	9 slot.
Nevada County.							
North Star	Water	20	850	7	90	2	Experimenting.
Idaho	Water	35	850	9	72	$2\frac{85}{100}$	5 slot.
Empire	Water	40	850	7	95	2	Experimenting.
Providence	Water	40	750	6–8	93	2	5 round punched.
Con. Wyoming	Water	16	800	7	92	2	
Nevada City	Water	20	750	7–9	93	$1\frac{3}{4}$	5 round punched.
Delhi	Water	8	1,000	6	94	$3\frac{1}{2}$	5 round punched.
Eagle Bird	Water	20	750	6–7	95	$1\frac{1}{2}$	40 mesh.
Spanish †	Water						6 slot.
Sierra County.							
Sierra Buttes	Water	60	850	8	86	$2\frac{1}{3}$	7 slot.
Young America	Water	40	750	7	80	2	7 slot.
Alaska	Steam	40	850	7	86	$2\frac{1}{4}$	6 slot.
Tuolumne County.							
Soulsby	Water	15	750	6	85	1	60 brass wire.
Keltz	Water	10	650	6	85	1	9 slot.
Buchanan	Steam	20	850	7–$7\frac{1}{2}$	90	2	8 slot, 8 wire.

* Four mills; revolutions per minute, 20; number of tons crushed per mill in 24 hours, 10–11.
† Four Huntington Mills; revolutions per minute, 60; number of tons crushed per mill in 24 hours, 30.

CONCLUSION.

The Mining Bureau having received so many inquiries for a description of the mining machinery in use at the mines, the State Mineralogist deemed it necessary to make himself acquainted with the practical details thereof by personal inspection as far as possible, and by contribution where circumstances would not admit of individual attention. All of the information has been carefully gathered, and that portion pertaining to the inquiries received at the Bureau has been especially tabulated.

One of the chief difficulties, for reasons heretofore given, has been to collect a correct statement of the value per ton of the ore worked at the mills; therefore mention is only made of that of the smallest assay value to show how low a grade can be profitably treated when done systematically.

Since the report has been made ready for the press there has been received at the Bureau the "Mines Statement of the Minister of Mines of New Zealand," from which the following is an extract:

"During my occupancy of the office I have the honor to hold in connection with mines, I have felt the want of a hand-book that, at a glance, would give to the inquirer every information in respect to mining companies and claims, the mode of working, and the class of machinery used in different mining districts, the area of ground, the number of miners employed, and the amount of capital invested in plant and machinery.

"Following my instructions the Department has been engaged in collecting material necessary for compiling such work, and, when ready, I propose to issue illustrative maps with it, so that it will afford every possible information in relation to the industry. I cannot pretend that I shall be able to present for information a perfect work or guide, for difficulties have already been encountered in collecting reliable materials on which to frame the book; but, notwithstanding, I hope within a few months to be able to supply a much needed want."

It would seem from the above that the same difficulties in obtaining information exist elsewhere, and that the identical requests were made as have been received at the Bureau; therefore for these reasons the State Mineralogist has deemed it advisable to add to his report the contributions annexed, also inserting the United States mining laws and regulations thereunder for ready reference, and other matter and tables which are constantly needed.

BULLION PRODUCTION OF MINES OF CALIFORNIA,

For the twelve months ending January 1, 1886.

(Combined reported and unreported production, from the Report of the Director of the Mint, 1885.)

County.	Gold.		Silver.		Total.
	Reported.	Unreported.	Reported.	Unreported.	
Amador	$1,835,591 23	$310,000 00	$406 40		$2,145,997 63
Butte	422,568 50	250,000 00		$3,700 00	676,268 50
Calaveras	397,538 23	130,000 00	2,558 20		530,096 43
Colusa	40,000 00		5,000 00		45,000 00
Del Norte	24,390 00	15,000 00	9 18		39,399 18
El Dorado	383,353 85	35,000 00			418,353 85
Fresno	67,500 00	7,000 00	2,456 00		76,956 00
Humboldt	20,130 37	9,600 00			29,730 37
Inyo	7,498 04	17,500 00	59,961 49	13,500 00	98,459 53
Kern	22,003 00	50,000 00			72,003 00
Lassen	7,500 00	7,500 00	150 00		15,150 00
Los Angeles		22,500 00	445 00	1,500 00	24,445 00
Mariposa	87,177 00	62,000 00	100 00		149,277 00
Merced		10,000 00			10,000 00
Modoc		60,000 00			60,000 00
Mono	477,860 41	5,000 00	88,349 49	3,500 00	574,709 90
Napa			5,000 00		5,000 00
Nevada	1,138,873 68	1,439,000 00	4,835 43		2,582,709 11
Placer	507,801 51	398,500 00	411 43		906,712 94
Plumas	688,307 71	152,000 00			840,307 71
Sacramento	253,522 00	100,000 00			353,522 00
San Bernardino	3,000 00	20,000 00	2,283,436 37	80,000 00	2,386,436 37
San Diego	71,125 00	20,000 00		2,000 00	93,125 00
San Joaquin		2,500 00			2,500 00
Shasta	236,004 75	181,000 00	9,123 38	100,000 00	426,228 13
Sierra	1,060,380 97	373,500 00	10 54		1,433,891 51
Siskiyou	119,658 70	219,000 00			338,658 70
Stanislaus	18,660 00				18,660 00
Trinity	175,347 69	162,800 00	10 00		338,157 69
Tulare		7,500 00			7,500 00
Tuolumne	149,503 34	171,400 00	1,273 00	200 00	322,376 34
Yuba	132,448 73	75,000 00			207,448 73
Totals	$8,347,744 71	$4,313,300 00	$2,463,535 91	$104,500 00	$15,229,080 62

NUMBER OF INCORPORATED COMPANIES.

From the Government Roster issued by the Hon. Thomas L. Thompson, Secretary of State, it appears that from July 1, 1884, to July 1, 1886, there were filed in his office two hundred and six (206) articles of incorporation of companies for mining and milling purposes.

U. S. PATENTS.

Department of the Interior, General Land Office,
Washington, D. C., November 13, 1886.

Henry S. Durden, *Esq., Acting Secretary State Mining Bureau, San Francisco, California:*

Sir: I am in receipt of your letter of the twenty-eighth ultimo, requesting the total number of mines in the State of California for which patents have been issued.

In reply, I refer you to the following table showing the number of mineral and coal patents issued for claims in the State of California up to this date, as compiled from the records of this office:

Sacramento Land District	870
Stockton Land District	273
Susanville Land District	18
Shasta Land District	135
San Francisco Land District	87
Marysville Land District	162
Visalia Land District	18
Bodie Land District	152
Los Angeles Land District	43
Humboldt Land District	51
Total number of mines patented in the State of California	1,809

Very respectfully,

WM. A. I. SPARKS,
Commissioner.

HYDRAULIC MINES ENJOINED.

C. E. Sexey, Esq., of the Anti-Debris Association, has furnished the State Mineralogist with a partial list, showing twenty-three hydraulic mines which have been enjoined.

WELLS, FARGO & CO.'S STATISTICS.

Wells, Fargo & Company,
San Francisco, December 31, 1886.

Dear Sir: The following is a copy of our annual statement of precious metals produced in the States and Territories west of the Missouri River (including British Columbia, and receipts by express from the west coast States of Mexico) during 1886, which shows aggregate products as follows: Gold, $30,773,759; silver, $53,776,055; copper, $9,276,755; lead, $9,185,192. Total gross result, $103,011,761.

As stated hitherto, the facilities afforded for the transportation of bullion, ores, and base metals, by the extension of railroads into mining districts, increase the difficulty of verifying the reports of the products from several important localities; and the general tendency is to exaggeration when the actual values are not obtainable from authentic sources; but the aggregate result, as shown herein, we think may be relied on with reasonable confidence as approximately correct.

States and Territories.	Gold Dust and Bullion by Express.	Gold Dust and Bullion by other Conveyances.	Silver Bullion by Express.	Ores and Base Bullion by Freight.	Total.
California	$12,579,356	$628,678	$918,403	$563,948	$14,690,385
Nevada	1,739,959		5,502,596	1,927,365	9,169,920
Oregon	451,907	250,000	1,310		703,217
Washington	139,694	25,000			164,694
Alaska	394,975	50,000			444,975
Idaho	1,816,500	300,000	2,602,000	3,015,000	7,733,500
Montana	2,100,000	500,000	7,840,000	10,400,000	20,840,000
Utah	19,140		3,080,759	5,531,696	8,631,595
Colorado	3,500,000		5,750,000	15,750,000	25,000,000
New Mexico	104,784	50,000	279,909	3,387,178	3,821,871
Arizona	583,827	100,000	1,371,083	4,048,468	6,103,378
Dakota	2,405,250	200,000	251,437		2,856,687
Mexico (west coast States)	469,490		1,627,204	12,000	2,108,694
British Columbia	692,845	50,000			742,845
	$26,997,727	$2,153,678	$29,224,701	$44,635,655	$103,011,761

The gross yield for 1886, shown above, segregated, is approximately as follows:

Gold	$29\frac{87}{100}$	$30,773,759
Silver	$52\frac{21}{100}$	53,776,055
Copper	$9\frac{00}{100}$	9,276,755
Lead	$8\frac{92}{100}$	9,185,192
Total		$103,011,761

Annual Products of Lead, Copper, Silver, and Gold in the States and Territories West of the Missouri River, 1870–1886.

Year.	Production, as per W. F. & Co.'s statements, including Amounts from British Columbia and West Coast of Mexico.	Product after deducting Am'ts from British Columbia and West Coast of Mexico.	The Net Product of the States and Territories West of the Missouri River, exclusive of British Columbia and West Coast of Mexico, divided, is as follows:			
			Lead.	Copper.	Silver.	Gold.
1870	$54,000,000	$52,150,000	$1,080,000		$17,320,000	$33,750,000
1871	58,284,000	55,784,000	2,100,000		19,286,000	34,398,000
1872	62,236,959	60,351,824	2,250,000		19,924,429	38,177,395
1873	72,258,693	70,139,860	3,450,000		27,483,302	39,206,558
1874	74,401,045	71,965,610	3,800,000		29,699,122	38,466,488
1875	80,889,057	76,703,433	5,100,000		31,635,239	39,968,194
1876	90,875,173	87,219,859	5,040,000		39,292,924	42,886,935
1877	98,421,754	95,811,582	5,085,250		45,846,109	44,880,223
1878	81,154,622	78,276,167	3,452,000		37,248,137	37,576,030
1879	75,349,501	72,688,888	4,185,769		37,032,857	31,470,262
1880	80,167,936	77,232,512	5,742,390	$898,000	38,033,055	32,559,067
1881	84,504,417	81,198,474	6,361,902	1,195,000	42,987,613	30,653,959
1882	92,411,835	89,207,549	8,008,155	4,055,037	48,133,039	29,011,318
1883	90,313,612	84,639,212	8,163,550	5,683,921	42,975,101	27,816,640
1884	84,975,954	81,633,835	6,834,091	6,086,252	43,529,925	25,183,567
1885	90,181,260	87,311,382	8,562,991	7,838,036	44,516,599	26,393,756
1886	103,011,761	100,160,222	9,185,192	9,276,755	52,136,851	29,561,424

The exports of silver during the past year to Japan, China, the Straits, etc., have been as follows: From London, $26,519,328; from Marseilles, $956,650; from Venice, $——; from San Francisco, $16,558,612. Total, $44,034,590, as against $56,109,949 last year. Pounds sterling estimated at $4 84.

UNITED STATES OF MEXICO.

Product of Gold and Silver in the Republic of Mexico from 1877 to 1886.

Years.	Gold.	Silver.	Total.
1877-1878	$661,385	$21,451,785	$22,113,170
1878-1879	662,524	21,405,330	22,067,854
1879-1880	474,632	23,383,448	23,858,080
1880-1881	380,301	23,583,135	23,963,436
1881-1882	382,752	24,009,525	24,392,277
1882-1883	380,419	22,921,921	23,302,340
1883-1884	420,000	24,240,000	24,660,000
1884-1885	385,000	25,037,356	25,422,356
1885-1886	450,000	26,000,000	26,450,000
Totals	$4,197,013	$212,032,500	$216,229,513

Exhibit of Coinage of Gold, Silver, and Copper in the Republic of Mexico, from the first of July, 1872, to the thirtieth of June, 1886, indicating approximately the Precious Metal product of the country for the years named.

Years.	Gold Dollars.	Silver Dollars.	Copper Dollars.
1872-1873	813,415	19,680,811	22,814
1873-1874	866,743	18,846,067	15,966
1874-1875	862,619	19,386,958	21,712
1875-1876	809,401	19,454,054	30,654
1876-1877	695,750	21,415,128	9,035
1877-1878	691,998	22,084,203	41,364
1878-1879	658,206	22,162,987	16,300
1879-1880	521,826	24,018,528	14,035
1880-1881	492,068	24,617,395	42,258
1881-1882	452,590	25,146,260	11,972
1882-1883	407,600	24,083,921	....
1883-1884	355,724	22,812,000	....
1884-1885	312,600	23,265,814	....
1885-1886	425,000	25,850,000	....
Totals	8,449,164	317,964,419	226,110

SUMMARY—TOTALS.

Gold	$8,449,164
Silver	317,964,419
Copper	226,110
Grand total	$326,639,693

Exhibit of the Coinage of Mexico from the Establishment of the Mints in 1537 to the end of the Fiscal Year of 1884–1886.

Dates of Coinage.	Gold.	Silver.	Copper.	Total.
Colonial Epoch.				
Unmilled coin from 1537 to 1731	$8,497,950	$752,067,456	$200,000	$760,765,406
Pillar coin, 1732 to 1771	19,889,014	441,629,211		461,518,225
Bust coin, 1772 to 1821	40,391,447	888,563,989	342,893	929,298,329
Totals	$68,778,411	$2,082,260,656	$542,893	$2,151,581,960
Independence.				
Iturbide's Imperial bust, 1822–1823	$557,392	$18,575,569		$19,132,961
Republic eagle, 1824 to June 30, 1873	45,040,628	740,246,485	$5,235,177	790,522,290
Totals	$45,598,020	$758,822,054	$5,235,177	$809,655,251
Republic.				
Eagle coin, July 1, 1872, to June 30, 1886	$8,449,164	$317,964,419	$226,110	$326,639,693

SUMMARY.

Colonial epoch, from 1537 to 1821	$2,151,581,960
Independence, from 1822 to 1872	809,655,251
Republic, from 1872 to 1886	326,639,693
Total	$3,287,876,904

The exhibits of production and mintage indicate a steady development of the mining interests of the United States of America, and also of Mexico, and with the increasing facilities of railway communications fostering every department of industry, the outlook for a continued growth in the product of precious metals is flattering.

JOHN J. VALENTINE,
Vice-President and General Manager Wells, Fargo & Co.

SAN FRANCISCO MINT.

COINAGE OF THE SAN FRANCISCO MINT FOR THE YEAR ENDING JUNE 30, 1886.

Gold, 1,455,550 standard ounces	$27,080,000 00
Silver, 42,051 $\frac{82}{100}$ standard ounces	49,066 20
Total value	$27,129,066 20

TABLE OF CHARGES.

Mint of the United States at San Francisco, on all bullion (or coin) not required to be parted or refined:

For each melt of 1,000 ounces or less	$1 00
For each melt over 1,000 ounces	One tenth of 1 cent per ounce.

PARTING AND REFINING CHARGES.

PARTING GOLD AND SILVER OR REFINING GOLD.

Rate per ounce gross.

Bullion containing less than 200 M gold	2 cents.
Bullion containing from 200 M to 399½ M gold	3 cents.
Bullion containing from 400 M to 699½ M gold	4 cents.
Bullion containing 700 M and over gold	6 cents.
Bullion containing over 100 M base metal, additional	½ cent.

And in addition to the above, on deposits requiring parting (except silver purchases) or refining gold:

For each deposit of 1,000 ounces or less	$1 00
For each deposit over 1,000 ounces	One tenth of 1 cent per ounce, gross.

For gold coin or standard gold bars the rate per ounce charged will be imposed only on the number of ounces required to be refined to raise the whole to standard.

Silver allowed the depositor is calculated on the basis of refining the gold to 990 M.

REFINING SILVER.

Rate per ounce, gross.

Bullion containing less than 897 M silver	2 cents.
Bullion containing 897½ M to 979½ M silver	1½ cent.
Bullion containing 980 M to 997 M silver	1 cent.

In addition to the above, on silver deposits requiring refining (except purchases) a charge on each deposit of—

1,000 ounces or less	$1 00
Over 1,000 ounces	One tenth of 1 cent per ounce, gross.

For standard or sterling bars the rate per ounce will be imposed only on the number of ounces required to be refined to raise the whole to the fineness of such bars.

Silver bullion below 997½ fine, not containing gold, deposited for fine bars, is subject to a refining charge.

Silver bullion deposited for bars, will be computed at $1 per standard ounce. Silver parted from gold deposits will be purchased at the rate fixed by the Director of the Mint, which at present, per ounce, is,

TOUGHENING CHARGE.

Gold bullion	½ to 2 cents per ounce, gross.
Silver bullion	¼ to 1 cent per ounce, gross.

ALLOY CHARGE.

On the number of ounces of copper required to reduce the bullion to a standard, 2 cents per ounce, Troy.

BAR CHARGE.

On bullion deposited for fine bars not required to be parted or refined, and for standard, sterling, or unparted bars:

Bars of fine gold, per $100 value	10 cents.
Bars of standard gold, per $100 value	10 cents.
Bars of fine silver, per ounce	¼ cent.
Bars of standard silver, per ounce, standard	½ cent.
Bars of sterling silver, per ounce	½ cent.
Bars of unparted bullion, per ounce, gross	½ cent.

No deposit of bullion is received of less than one hundred dollars, or so base as to be deemed unsuitable for the operations of the Mint.

TABLES FROM REPORT OF THE DIRECTOR OF MINT.

From the report of the Director of the Mint, upon the production of the precious metals in the United States, during the calendar year 1885, the following tables are published, from the compilation of the Treasury Department, Bureau of the Mint:

Statement showing the Value and Character of the Gold and Silver used in the Arts and Manufactures during the Calendar Year 1883, as reported by the persons and firms who had been addressed.

GOLD.

Manufactures.	Number Manufactur'g.	United States Coin.	Stamped United States or Refinery Bars	Old Jewelry, Plate, and other Old Material.	Foreign Coin.	Native Grains, Nuggets, etc.	Wire, or Rolled Plate.	Total Gold.
Watch-cases	32	$575,812	$2,976,550	$38,101	$1,508	$520	$5,817	$3,598,308
Watch-chains	14	374,997	286,884	1,907	600	135,410	27,202	827,000
Dental supplies	7	700	33,437	3,775				37,912
Pens	14	14,578	90,325	6,100	5,227	2,134	27,560	145,924
Instruments	45	68		3,568		621	942	5,199
Leaf	51	178,424	792,551	57,498	6,816	6,700	42,835	1,084,824
Plate	219	379,291	67,928	5,500	590	8,933	66,626	528,868
Spectacles	41	192,400	7,169	8,830	1,315	4,987	727	215,428
Chemicals	27	7,438	7,685	3,551	550	207	12,180	31,611
Jewelry and watchmakers' supplies	11	24,498	13,983	9,123		1,569	30,084	79,227
Jewelry and watches	2,273	3,125,738	2,861,149	738,688	177,794	541,306	458,745	7,906,163
Totals	2,734	$4,875,587	$7,137,661	$876,641	$194,400	$702,387	$672,688	$14,459,464

SILVER.

Manufactures.	United States Coin.	Stamped United States or Refinery Bars.	Old Jewelry, Plate, and other Old Material.	Foreign Coin.	Native Grains, Nuggets, etc.	Wire, or Rolled Plate.	Total Silver.	Total Silver and Gold.
Watch-cases	$35,200	$1,777,193	$31,937	$219	$1,000	$50	$1,845,599	$5,433,907
Watch-chains	524	14,768			6,790	1,462	23,544	850,544
Dental supplies	450	6,060				228	6,738	44,650
Pens	216	4,254	100	1,655	505		6,730	152,654
Instruments	931	3,752	693	755	864	6,995	13,990	19,189
Leaf	11	22,697	4,107	300	835	18,933	46,883	1,131,707
Plate	16,856	1,710,515	40,761	7,690	8,495	281,977	2,066,294	2,595,162
Spectacles	3,631	16,461	1,254	215	250	1,981	23,782	239,210
Chemicals	9	375,429	35,554	500	1,580	3,347	416,419	448,030
Jewelry and watchmakers' supplies	245	4,806	800		1,505	975	8,331	87,558
Jewelry and watches	158,564	616,237	106,745	142,949	49,733	23,992	1,098,220	9,003,383
Totals	$216,637	$4,552,172	$221,951	$154,273	$71,557	$339,940	$5,556,530	$20,015,994

Statement showing Value and Character of the Gold and Silver used in the Arts and Manufactures during the Calendar Year 1885, as reported by the persons and firms addressed.

GOLD.

Manufactures.	Number Addressed.	Replied.	Manufacturing.	United States Coin.	Stamped United States or Refined Bars.	Foreign Coin.	Old Jewelry, Plate, and other Old Materials.	Native Grains, Nuggets, etc.	Wire or Rolled Plate.	Total.
Chemicals	341	219	39	$32,040	$13,903		$6,063	$29	$4,341	$56,376
Platers	634	348	226	257,741	218,831	$801	178,510	24,295	15,537	695,715
Gold pen manufacturers	34	22	11	7,433	34,886	2,867	990	3,526	6,753	56,455
Gold and silver leaf	72	51	46	58,150	527,453	2,000	31,050	19,700	39,001	677,354
Dental and surgical instruments	154	98	47	3,970	149,186	100	14,942	2,400	4,188	174,786
Spectacles and opticals	383	217	79	52,707	62,420	642	16,269	314	2,291	134,643
Miscelleneous	106	73	27	116,604	44,168	8,000	17,337	1,000	3,835	190,944
Jewelry and watches	6,330	3,352	2,232	2,298,733	5,183,187	164,503	582,554	451,629	485,241	9,165,847
Totals	8,054	4,380	2,707	$2,827,378	$6,234,034	$178,913	$847,715	$502,893	$561,187	$11,152,120

SILVER.

Manufactures.	Number Addressed.	Replied.	Manufacturing.	United States Coin.	Stamped United States or Refined Bars.	Foreign Coin.	Old Jewelry, Plate, and other Old Materials.	Native Grains, Nuggets, etc.	Wire or Rolled Plate.	Totals.
Chemicals				$91	$305,165		$73,561	$106	$2,165	$381,088
Platers				32,824	1,990,587	$25,434	43,191	12,798	157,922	2,262,756
Gold pen manufacturers				55	3,191		249	558	5	4,058
Gold and silver leaf					21,881		708	20	23,512	46,121
Dental and surgical instruments				4,682	107,717	1,401	7,057	4,450	2,494	127,801
Spectacles and opticals				2,587	42,424	155	2,750	210	942	49,068
Miscellaneous				838	5,330		268	70	1,017	7,523
Jewelry and watches				92,567	1,360,308	35,718	117,629	85,060	28,716	1,719,998
Totals				$133,644	$3,836,603	$62,708	$245,413	$103,272	$216,773	$4,598,413

CONSUMPTION OF GOLD IN THE INDUSTRIAL ARTS IN THE UNITED STATES.

FISCAL YEAR.	Estimate of Director of the Mint. Consumption of United States Gold Coin.	Estimate by Mr. Muhleman, of consumption of Gold Coin and Bullion.
1874	*$30,000,000 (1874–1880)	$12,600,000
1875		12,900,000
1876		13,900,000
1877		15,300,000
1878		15,200,000
1879		15,900,000
1880		16,700,000
1881	3,300,000	17,800,000
1882	2,700,000	18,000,000
1883	2,500,000	17,500,000
1884	4,875,000	17,000,000
1885	5,000,000	15,600,000
Totals	$48,375,000	$188,400,000

*Includes short estimates for 1881–1882, and 1883.

*ANNUAL INDUSTRIAL CONSUMPTION OF GOLD AND SILVER BY THE PRINCIPAL NATIONS OF THE WORLD, FROM LATEST AUTHORITY.

COUNTRIES.	Population.	Gold. (Fine ounces.)	Value.
United States (Burchard)	58,000,000	626,925	$13,000,000
England (mean of several authorities)	36,000,000	546,550	11,500,000
France (Dumas)	37,000,000	401,875	8,600,000
Germany (Soetbeer)	45,000,000	385,800	8,200,000
Switzerland (Lardy)†	2,846,000	321,500	6,600,000
Austria-Hungary (Nibauer)	37,800,000	....	....
Other countries (Soetbeer)	230,000,000	450,100	9,500,000
Totals	446,646,000	2,732,750	$57,400,000

COUNTRIES.	Silver. (Fine ounces.)	Coining Value, $1.2929.	Total Value of Gold and Silver.	Per Capita. Gold.	Per Capita. Silver.
United States (Burchard)	3,697,250	$4,000,000	$17,000,000	$0 22.4	$0 07
England (mean of several authorities)	2,604,150	3,000,000	14,500,000	32	08.3
France (Dumas)	2,411,250	2,800,000	11,400,000	23.8	07.5
Germany (Soetbeer)	2,636,300	3,000,000	11,200,000	18.2	06.6
Switzerland (Lardy)*	835,900	1,000,000	7,600,000	2 31.8	35
Austria-Hungary (Nibauer)	835,900	1,000,000	1,000,000	....	02.9
Other countries (Soetbeer)	3,697,250	4,000,000	13,500,000	04.1	01.7
Totals	16,718,000	$18,800,000	$76,200,000		

*Consumption as cited by Ottomar Haupt. "L'Histoire Monétaire de Notre Temps;" Paris, pp. 21, 22.

†According to the census of Switzerland of 1870, the annual production of watches in that country for that year was 1,600,000, representing a total value of 88,000,000 francs. Thirty-seven thousand nine hundred and sixty-nine persons were reported to be engaged in the business of watch-making in the four cantons of Switzerland famous for that industry. Larousse Dictionnaire Universel, vol. 14, p. 1221.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FOR THE YEAR 1885.

Compiled by J. B. Randol, New Almaden, California.

	Ætna.	Napa C.	Great Western.	Guadalupe.	New Idria.	Sulphur Bank.	Redington.	Great Eastern.	Various.	Total—flasks.	New Almaden.	Grand Total—flasks.	Price in San Francisco—per flask.	
													Highest.	Lowest.
January	189	131	172	0	190	24	40	37	0	783	1,700	2,483	$33 00	$32 50
February	96	180	245	35	70	85	24	75	0	810	1,506	2,316	32 50	32 50
March	88	145	314	0	80	83	0	33	19	762	1,500	2,262	32 50	31 00
April	142	145	340	0	80	69	0	37	0	813	2,003	2,816	31 00	30 00
May	62	190	269	0	75	194	0	0	3	793	2,000	2,793	29 00	28 50
June	112	250	330	0	62	91	50	63	5	963	1,750	2,713	30 00	29 00
July	45	191	321	0	75	209	43	50	10	944	1,750	2,694	30 00	29 75
August	118	175	324	0	80	150	49	0	47	943	2,104	3,047	29 75	29 50
September	201	180	347	0	95	85	57	0	77	1,042	1,936	2,978	30 50	29 50
October	52	185	236	0	85	123	42	65	82	870	1,598	2,468	30 50	30 00
November	54	190	292	0	122	61	43	43	87	892	1,576	2,468	30 00	29 75
December	150	235	279	0	130	122	37	43	62	1,058	1,977	3,035	32 00	30 00
Totals	1,309	2,197	3,469	35	1,144	1,296	385	446	392	10,673	21,400	32,073	$32 00	$28 50
Production in 1884	2,931	1,376	3,292	1,179	1,025	890	881	332	7	11,913	20,000	31,913	$35 00	$26 00
Production in 1883	*	5,890	3,869	84	1,606	2,612	1,894	1,669	101	17,725	29,000	46,725	28 50	26 00
Production in 1882	....	6,842	5,179	1,138	1,953	5,014	2,171	2,124	241	24,662	28,070	52,732	29 05	27 35
Production in 1881	....	5,552	6,241	5,228	2,775	11,152	2,194	1,065	584	34,791	26,060	60,851	30 75	27 90
Production in 1880	....	4,416	6,442	6,670	3,209	10,706	2,139	1,279	1,600	36,461	23,465	59,926	34 45	27 55

San Francisco, December 31, 1885.

* Production of Ætna and Napa Con. not segregated in former years.

PRODUCTION OF QUICKSILVER IN CALIFORNIA IN THE YEAR 1880.

Compiled by J. B. Randol, New Almaden, California.

	Ætna.	Napa C.	Great Western.	Guadalupe.	New Idria.	Sulphur Bank.	Redington.	Great Eastern.	Various.	Total—flasks.	New Almaden.	Grand Total—flasks.	Price in San Francisco—per flask.	
													Highest.	Lowest.
January	162	147	339	0	70	100	42	73	34	967	1,431	2,398	$32 50	$32 00
February	132	192	274	0	175	108	21	53	45	1,003	1,100	2,103	32 50	32 50
March	209	218	226	0	20	91	21	43	75	903	1,522	2,425	33 00	32 50
April	328	172	115	0	90	172	36	62	62	1,037	1,256	2,293	33 00	33 00
May	228	128	99	0	101	36	18	76	95	781	1,600	2,381	34 00	33 00
June	276	123	126	0	110	113	19	71	78	916	1,806	2,732	36 00	34 00
July	345	138	138	0	95	98	21	64	127	1,029	1,572	2,601	37 00	36 00
August	313	74	156	0	105	119	35	76	84	962	1,240	2,202	37 00	36 75
Totals	1,993	1,192	1,473	0	766	837	219	518	600	7,598	11,527	19,135	....	....

HYDROMAGNESITE, FROM LIVERMORE, CALIFORNIA.

(Analyzed and contributed by F. Gutzkow, E.M.)

Moisture	.75
Silica, Alumina, Ferric oxide	1.25
Lime	Trace.
Magnesia	43.00
Carbonic acid	36.30
Water (in combination)	18.70
	100.00

Calculated for the pure mineral:

Magnesia	43.88	4 MgO
Carbonic acid	37.04	3 CO_2
Water (in combination)	19.08	4 H_2O
	100.00	

MINE DRAINAGE.

(By Chas. G. Yale.)

The principal methods employed for extracting water from mines in California and on the Pacific Coast, generally are: Cornish pumps, bailing tank, steam (or compressed air) pumps, and hydraulic pumps. For shallow mines, where there is little water, iron water buckets are used. The best form is made barrel-shaped, for use in shafts or winzes, where there are no guides—this shape preventing them from catching on projecting timbers or rocks. The water bucket has a fixed bale, as this bucket does not turn over, but is emptied by lowering until a spindle in its bottom rests on the bottom of the water box, when the spindle opens the valve in bucket bottom. This valve opens automatically when filling, and automatically closes when the bucket begins to rise. Oval and cylindrical bailing buckets are also made for work in vertical shafts, and are arranged with shoes for wooden shaft guides. They are sometimes arranged for rope guides, also. Rectangular baling tanks are also made, arranged for self-dumping. These tanks are so constructed as to discharge themselves on arriving at the station, without reversing the engine, and there is no man required to let the water out. Such tanks are made for wooden shaft guides.

Water skips are of the same character for inclined shafts. The bale is attached to a pivot back of the center of gravity, so that it will tip when it is run over the dumping track. The dumping is accomplished by making the rear wheels with a projecting face of smaller diameter, which catches on the dumping track and elevates the back end, and the skip is thus tipped to a proper angle for dumping. When lowering, the rear wheels must necessarily pass down first, returning the skip to its proper position. These and self-dumping skeets can be used for ore and water both, or either. The self-dumping skeets are designed for use in vertical shafts. For sinking purposes they are very handy, for they can be shoveled into or bailed into. In many cases, pumping from the bottom of a shaft while sinking can be dispensed with, as the water and dirt can be put into the skeet at the same time. These skeets are made with steel or iron boxes, and with single or double bar frames, made of Norway iron. They are self-dumping. The following tables show the various sizes, capacities, and

weights of the forms of tanks referred to, as given by the Risdon Iron Works of San Francisco:

Oval Bailing Tanks.					Cylindrical Bailing Tanks.			
Lesser Diameter. Inches.	Greater Diameter. Inches.	Height. Inches.	Capacity. Gallons.	Weight. Pounds.	Diameter.	Height.	Capacity. Gallons.	Weight.
30	40	60	245	875	30	60	180	775
32	42	72	330	1,050	30	66	198	820
36	48	84	490	1,400	30	72	216	865
42	48	96	650	1,750	36	60	265	1,350
42	54	96	700	1,950	36	66	290	1,400
					36	72	315	1,460
					36	78	340	1,530

Rectangular Self-Dumping Bailing Tanks.					Ore and Water Skips.		Self-Dumping Skeets.	
Width. Inches.	Length. Inches.	Height. Inches.	Capacity. Gallons.	Weight. Pounds.	Capacity. Cubic Feet.	Weight. Pounds.	Contents. Cubic Feet.	Weight. Pounds.
32	42	72	420	1,400	10	500	20	1,700
36	48	84	620	1,800	15	700	30	2,000
42	48	96	820	2,400	20	900	40	2,400
42	54	96	940	3,000			50	2,600
42	60	108	1,180	4,000			60	2,800
							70	3,000

Tanks of this character will handle a great deal of water, and can be replaced by cages when not needed. They are too simple to get out of order often and are readily repaired. In many places they are preferred to pumps, and are frequently kept in readiness as a substitute for Cornish pumps when the rods of the latter break.

Local practice varies greatly as to the means adopted for handling water. Some one form of pump does well in the first of the mines of the camp useing one, and others follow the example set. Cornish pumps are more frequent in older mining districts than in newer ones, and in larger mines than in smaller ones.

In the earlier history of mining on this coast, neither great depths nor great quantities of water had to be considered. A simple hurdy-gurdy water wheel, driven by a jet from a high head, was the prime mover. A pump-bob of simple construction and a bucket-lift, all of wood, was the shaft work. Many a rig like this may still be seen running in the smaller mines. In the quartz mines steam power was used, mainly geared engines, driving a line of plunger pumps. As the mines increased in depth, and larger quantities of water had to be handled, large engines and heavy gears came into vogue. In draining very great depths, the heavy weight of the pit-work, which is of so much importance in any direct-acting system, proves the destruction of the geared system; since in working geared pumping engines at great depths with heavy pit-work, the speed must be very slow. Geared engines for great depths have, therefore, the pumps very large and are run at very slow motion, otherwise frequent breakages would condemn the whole system.

For deep mine pumping the Cornish bucket and plunger pumps are very extensively used. They are driven from the surface by a system of gear-

ing directly connected with the engine shaft. The main gear is connected to the head of the bob, by a pitman, one end of which engages into a wrist-pin set into one of several bosses cast on to the arms of the main gear, so placed as to give any desired throw to the pumps. Where the depth of the shaft is so great that one pump is insufficient to raise the water to the surface, a system of two or more pumps is made use of, the lowest one pumping into a tank station at a convenient height above it, from which the pump next overhead in its system takes its suction and discharges either into a similar tank or directly out at the surface.

For depths below 300 or 400 feet, and for the handling of large volumes of water, the pumps generally preferred are those termed "Cornish bucket" or "Jack-head," and the plunger pumps. In the jack-head pump the working bucket is packed with leather, which is secured to the body of the bucket by a brass ring. The suction chamber is bolted directly to the lower end of the working barrel, and has the suction pipe and wind-bore bolted to its lower flange. The "goose-neck" bolts on the top of the barrel, and has a bonnet and stuffing box through which the bucket rod passes. The upper clack sets on the branch of the goose-neck, with the column bolted on its upper flange. The clack chambers have doors, through which the clacks are removed for repairs. A door is sometimes made in the goose-neck, through which the working bucket may be taken out without taking oft the bonnet from the top.

Jack-head pumps are best adapted for lifting water from cisterns or permanent sumps, although they are frequently used in sinking.

The common lift pump is different from the jack-head pump in that it has no goose-neck. The bucket-piece is bolted on the top of the working barrel, with a door for the removal of the bucket. On this, in a direct line, is set the column, with the pump-rods inside of it. The working bucket is the same as that for the jack-head pump. Of course there is only one clack. The advantage of these pumps in sinking is that the bucket can be lifted through the column for repairs while the whole pump is submerged in water.

The connecting rods through which the pump takes the motion are made of heavy timbers, strapped at the joints with iron plates and bolted through, and connect at the upper end with the pitman attached to the nose-piece of the bob. This pitman is furnished either with a cross-head or guide rollers, to keep it in position. The usual speed at which these pumps is run is about 12 strokes per minute.

The following table giving sizes, capacity, and horse power required for the various sizes of Cornish pumps, is furnished by the Pacific Iron Works, San Francisco:

Diameter of Plunger, in inches.	Length of Stroke, in feet.	Number of Strokes per Minute.	Gallons per Minute.	Horse power for each 100 feet Lift.
4	4	18	40	1
6	6	14	92	2
8	8	12	188	3½
10	8	12	294	5¾
12	8	12	390	7½
14	8	12	576	11
16	8	12	752	14
18	8	10	793	16

The pumps employed in the deep shafts on this coast are all of the same general character, and do not differ materially in principle from

those used in deep mines in other countries. They are, as stated, either lifting pumps or force pumps. In a complete set of deep pumps the two kinds are combined, the former being applied to raising the water from the bottom of the shaft to the height adapted to the capacity of a single pump; the latter forcing the water upward to the stations, or to the point of discharge. The following descriptions of lifting and force or plunger pumps, from Hague's volume on "Mining Industry," in Clarence King's report on the United States Geological Exploration of the Fortieth Parallel, are very clear:

The lifting pump consists of a cast-iron cylinder or "working barrel," from 8 to 12 inches in diameter and from 8 to 12 feet long, smoothly turned inside, on which a closely fitting piston, that has an upward opening valve, may be made to move up and down by means of a rod to which it is attached. At the bottom of the cylinder is a valve opening upward, by means of which the water, once drawn from below into the cylinder, is retained there. Below the cylinder is the suction pipe, dipping below the surface of the water to be lifted. Above the cylinder is an iron pipe or column of elevation, in which the water is raised, by the upward movement of the piston, to any desired height. When the piston in the cylinder is moved upward, its valve remaining closed and the lower end of the suction pipe being immersed in the water, the pressure of the exterior air causes the water to rise in the suction pipe and to pass through the retaining valve, at the bottom of the cylinder, in accordance with the well-known principle involved in all suction pumps. On the downward stroke of the piston the retaining valve at the bottom of the cylinder closes, while the valve in the piston opens and the water passes through the piston. On the succeeding upward stroke the water now above the piston is lifted by it, while a new supply is drawn into the cylinder in the manner just described, to be lifted by the next upward stroke.

The pipe or column in which the water is raised above the piston is sometimes placed upon and directly over the cylinder, in which case the rod to which the piston is attached passes up through it, and is connected above with the motive power. But commonly the pipe, or column of elevation, is fixed at one side and connected by a short horizontal or curved piece with the cylinder, the top of which is then fitted with a stuffing box. The piston-rod then passes through the latter, and is then connected with the main pump-rod working on the shaft, from which it receives its motion.

The column may be of any desired height to which the strength of the material is adapted. As the lifting pump is generally only employed at the bottom of the shaft to raise the water to the force or power pump above, the height of the column varies with the circumstances. In shafts where sinking is in progress, the column of the lifting pump is constantly being extended as the shaft deepens, until a sufficient depth (200 feet or more) has been attained for the establishment of a force or plunger pump, when the lifting pump is detached from the column, the force pump put in its place at a suitable distance above the bottom, and the lifting pump again employed for sinking deeper with a short but gradually extending column.

The force pump or plunger pump forces the water upward in its column of elevation by the descent of the piston or plunger. This pump consists of a cast-iron cylinder or "plunger case," usually 10 or 12 feet long and from 8 to 12 inches in diameter, in which a solid cylindrical piston, nearly as long as the cylinder, is caused to play with an upward and downward motion; the piston passes through a stuffing box at the top of the cylinder, and is then connected with the pump-rod that gives it motion. Below the cylinder is a side or branch pipe connecting the cylinder with a valve-

chamber and the column of elevation. The valve in this chamber retains the water drawn through it from the wind-bore, or suction pipe, which is immersed in the cistern. The valve at the bottom of the column of elevation opens for the passage of the water into the column, and closes to retain it there. When the piston ascends the valve opens and the space in the cylinder, below the piston, fills with water; when the piston descends the valve closes and the other valve opens and the column of water is forced upward to the point of discharge to any desired height.

The piston or plunger of the force pump is a smoothly turned cylinder, 8 to 12 inches in diameter, and 10 to 12 feet long. It is cast hollow, of iron, about one inch in thickness. In order to attach it to the pump-rod, by which it is set in motion, a suitable stick of timber considerably larger than the piston is made to fit snugly into the inside of the cylinder, or hollow piston, entirely occupying the interior space; being driven tightly in it is wedged at the bottom. The top, projecting above the end of the cylinder, is then attached to the main pump-rod.

Another method is to have the plunger cast with a stout flange at the upper end, by means of which a head of cast-iron is bolted to it, carrying two uprights with a stout iron pin. To the end of the pump-rod is securely attached an iron stub-end, which is furnished with a strap, boxes, jib, and key, forming a connecting link such as is commonly used for attaching the connecting rod of an engine to the crankpin. By means of this link the pump-rod is attached to the pin in the head that is bolted to the plunger, as just described.

The plunger-case and valve chambers rest upon stout timbers, which are firmly established in the shaft in the most substantial manner. The column rests upon the valve chamber, and is itself further supported by timbers fixed at intervals in the shaft, and so arranged as to embrace the pipe directly under the flange by which the sections of the column are joined together, and furnish a bearing for these to rest upon. The pump column generally used at the more important pumping works, is a pipe having a diameter of 10, 12, or 14 inches. The best pipe column is of wrought iron, though cast pipe is very common.

It will be seen from the foregoing that the force pump performs its work of raising the water on the downward stroke of the piston, while the lifting pump does its duty on the upward stroke. The force pumps need to be very firmly set, and are, therefore, only employed where they can be permanently and solidly established in a position easily accessible for repair and not very liable to be submerged. The lifting pumps are well adapted to work in the bottom of the shaft, their method of construction and operation fitting them to draw water from the very bottom of the shaft without the use of a cistern, and to be extended, foot by foot, as the sinking proceeds; not requiring to be placed with so much care as the plunger pumps, and having the advantage also of being operated as well, even when the water rises above them in the shaft.

In order to extend the pump in depth as the sinking proceeds, the working parts of the pump, namely, the suction pipe and working barrel, being suspended by heavy chains to a turret or windlass fixed at the station above, are detached, with the connecting pipe, from the bottom of the column and lowered 10 or 12 feet, sufficiently to allow of introducing another length of pipe under the column, already in place; this additional length having been attached to the column, the working parts are again connected with the column thus extended, and are continued in operation until the sinking has so far progressed as to require the addition of another length of pipe, when the above described proceeding is repeated. In some

mines the suction pipe dipping into the sump is a stout piece of suction hose of diameter equal to that of the short iron pipe below the working barrel, to which it is closely fitted and attached. It has the advantage of flexibility and may be more easily protected against injury from blasting than iron pipe. The lifting pump discharges into a cistern from which the force pump takes its supply to be raised to the surface or to the next station above.

The motion of the piston, or plunger, in its cylinder, is imparted to it by the pump-rod, a continuous piece of timber, which is suspended in the shaft alongside the column, extending from the surface to the bottom of the mine, and to which the plungers are attached. The pump-rod is composed of timbers 6, 8, 10, or 12 inches square, or even larger, joined to each other so as to form a continuous piece. The method of joining the sections composing the rod varies in different mines. Sometimes they are joined by a simple splice, and strapped on four sides with long iron plates. In other mines the sections are joined in a more complicated manner by a beveled splice and key, and then strapped. In other cases the square ends of the sections are brought together without any splice, and joined simply by means of iron straps. Sometimes the straps are so formed that a key can be inserted. When these keys are driven in as tightly as possible, so as to bring the ends of the timbers closely together, and so prevent any lost motion in the action of the rod, the two straps for the remaining two sides are put on and bolted together.

The motion of the rod is communicated to it from the engine by means of an oscillating "bob" on the surface. These bobs are made of various forms, but correspond generally to the form of the "walking beam" of the old style marine engine. The method of connection with the engine also varies. The pumping engine drives, by means of the piston, the pump wheel, to one side of which is attached, by means of a wrist-pin, one end of the pitman. As the wheel is set in revolution by the engine, the pitman receives a reciprocating motion, the length of the stroke being determined by the distance of the wrist-pin from the center of the wheel. The other end of the pitman being connected to the kingpost of the bob, causes that to oscillate, giving to the pump-rod in the shaft an upward and downward motion. The upper section of the rod is usually connected to the "nose" of the bob and the next lower section of the rod by means of a strap and boxes, so as to allow for the vibration caused by the angular motion of the bob; deeper in the shaft the sections are joined together as described above, forming one continuous piece, which is guided in its movement by timbers so arranged as to prevent vibration of the rod. Timbers are also placed in the shaft at frequent intervals to prevent the rod from falling far in case of breakage, by furnishing support to the catching pieces attached to the rod for this purpose. The length of stroke, or upward and downward movement of the rod, varies from 3 or 4 to 7 or 8 feet, and the number of strokes per minute from 3 or 4 to 10 or 12, according to size and character of pump and duty required of it.

The weight of this pump-rod in most cases considerably exceeds that of the water to be raised, so that, descending by its own gravity, it exerts sufficient force to raise the column of water without requiring additional power from the engine. For the next stroke, however, the engine must lift the total weight of the rod to the required height. In order to prevent the too rapid descent of the rod and to equalize the work of the engine on either stroke, counter-weights are attached to the opposite end of the oscillating bob at the surface. The descending rod must raise the counter-weight, which, on the reverse stroke, assists in lifting the rod. For deep shafts, as

the rod increases in length and weight, additional counter-weights are applied, by establishing at various stations in the shaft similar oscillating bobs, attached at one end to the rod and bearing at the other a heavily weighted box. Angle bobs are used to change direction of motion, in changing from a vertical to an incline shaft. They are of various forms.

It is unnecessary in this instance to go into any description of the numerous forms of engines which are employed to drive this pumping gear. Different makers claim special advantageous features, and no one type is in exclusive use. The ordinary single-geared pumping engine has the pinion placed on the engine shaft, gearing into the spurwheel, to which a pitman rod is attached. In the double-geared engine two pinions are placed on an engine shaft and the pitman rod-pin is placed between the two spurwheels, thus adapting it for very heavy work. The simplest form of direct acting engines consists of a single high pressure cylinder connected directly to the main-bob; the king-post of this is larger than the nose piece, so as to give the engine leverage on the pumps. The valve gear is generally so arranged and adjusted that steam can be cut off at any portion of the stroke, or the stroke of the piston can be shortened. In some of the horizontal direct-acting compressed engines the pitman is connected directly to the crosshead and king-post, the connections between king-post and flywheel being made by two side rods.

Sometimes two lines of pump rods are used in the same shaft, working a double line of pumps from the same bob, in which case no counterbalance is necessary. Often, too, there is a double line of plunger pumps, when the main pump-rod extends down between the pumps to the next set below, and so on until the bottom pump is reached. An angle plate is attached to each side of the rod by bolts common to both, and to each of which the pump plungers are attached.

The ordinary surface bob is made principally of wood. The irons for the king-post and nose-piece are each made on two pieces, with sockets for angle-braces, and securely bolted together by bolts running through the timber. The saddle-plate is made in three pieces, and made to admit of the trunnion shaft being placed on a line with the nose and tail-pins. The trunnion shaft is made of hammered iron, and secured by running through the beam, and being keyed to the side and saddle-plates. The whole is drawn together by wrought-iron straps and turnbuckles. The back of the beam is extended to admit of a box being attached, to be filled with old iron, rocks, or other heavy substances, for a counterbalance. These bobs are sometimes made wholly of iron. The balance bobs, made for use under ground, also vary in form. Those interested in forms of bobs and methods of connection to engine, may see excellent illustrations of various forms in one of the business circulars issued by the Union Iron Works of San Francisco.

Recently, in this State, steam has been displaced by water power for running the pumping rig of several important mines.

It may be well to cite some examples of Cornish pumping rigs in California to illustrate capacity, etc. The examples are all taken from actual works in California mines:

A.—Cornish pumping rig driven by 80-horse power engine, which also hoists. In summer, pumps 4 hours in 24; in winter, constantly. Capacity, 14,000 gallons per hour; rod 1,000 feet. One 8-ton counterbalance at surface.

B.—Cornish pumping rig driven by 8-foot hurdy-gurdy wheel, using 12 inches of water at 400 feet fall. Capacity, 3,500 gallons; rod, 450 feet. One 3-ton counterbalance.

C.—Rig driven by hurdy-gurdy under-wheel, using 24 inches of water in summer, and 35 inches (about 30 h. p.) with 400 feet fall. Capacity, 10,000 gallons per hour. Rod, 410 feet; one 4-ton counterbalance. In winter a Hooker pump, with capacity of 10,000 gallons, is also used.

D.—Myers' cut-off Cornish pumping engine, 75 h. p. Rod, 500 feet. Two counterbalances weighing 11 tons.

E.—Compound Cornish engine, double acting, with two rods down to 400 feet, and single rod for 200 feet below; capacity, 22,500 gallons per hour. One 10-ton counterbalance.

F.—Cornish engine, 110 h. p. Capacity, 10,000 gallons per hour. Rod, 1,300 feet. Lever bobs, with counterbalances, together weighing 14 tons.

G.—Cornish engine, 80 h. p. Rod, 1,300 feet; two counterbalances, 2 tons each.

H.—Cornish rig run by water power. Jackhead pump operated by 400 feet of rod. One counterbalance.

I.—Cornish rig run by hoisting engine. Capacity, 30,000 gallons. Rod, 900 feet. One 4-ton counterbalance.

J.—Cornish pumping rig run by hoisting engine. Capacity, 6,000 to 7,000 gallons per hour; 500 feet force; 300 feet lift; one 1½-ton counterbalance.

Those desiring to examine details of very large rigs of this kind may see descriptions of those in use on the Comstock, Nevada, in volume XIII of the Census Reports, 1880, page 149.

A form of pumping apparatus recently introduced in California, is the Knight hydraulic pumping engine. It is specially designed for pumping water out of mines to any depth where there is water pressure above the drain tunnel. The hydraulic engine (or wheel) can be bolted to the shaft timbers at the drain tunnel, and a pump-rod run down to a special plunger pump made for use in connection with the Knight engine. By using this engine at the drain tunnel the gears, bob, etc., below, are saved. Both the engine and pump can be set on the same bed-plate if desired, and the whole apparatus secured in the shaft below the surface in drain tunnel. After operating the engine, the water is exhausted into the discharge pipe of the pump. The only gain in this is the doing away with the pump-rod. Nothing is gained in power.

Steam force or plunger pumps are now much more largely used than formerly, having been much improved and specially adapted for mining purposes. There are many forms kept on sale by various makers, among the best known being the Knowles, Blake, Dow, Hooker, Worthington, Cameron, Cope & Maxwell, and Deane. These and similar pumps are made in great variety of form and size, but are more or less similar in general appearance and design, the different makers, however, adopting details of construction originating from their special experience, or from their experience arising in practice under different conditions of use. For opening up mines, re-prospecting abandoned ones, working them under bond, temporarily, etc., the steam pumps are very advantageous. A steam pumping rig has the advantage of greatly reduced first cost over the Cornish system, and lately the makers of steam pumps claim equal economy with that plan. There is no doubt of one thing, that twice the number of mines have been opened lately, with steam pumps, than would have been the case had expensive Cornish rigs been absolutely necessary, the plant of steam pumps costing so much less originally. By their use a mine can be opened and tested. Moreover, there are many locations which it would not pay to test if steam pumps could not be obtained to do it with.

For a few thousand dollars a boiler and steam pump can be procured to drain a mine while prospecting it, when a Cornish rig of same capacity would cost four or six times as much.

The horizontal plunger pumps are mainly used for station pumps, and are made to raise the water on a single lift as high as 1,000 feet. The particular advantages of the direct acting system are the first cost, ready means of placing in position, etc., especially for prospecting purposes. The steam is brought down the shaft in jacketed pipes, and the pipe column brought up to the surface, the pump being below. The best makers now construct these pumps so the parts are readily accessible, muddy water can be raised, and have otherwise perfected them greatly.

A class of vertical sinking steam pumps has come into use quite largely of late, having been much improved. Their peculiar feature is the special adaptability for shaft sinking purposes. They are of comparatively light weight, portable, and require a very limited space for operation. A steady continuous stream of water is thrown and there is very little jar. As an illustration of this class of pumps engravings are here given of the Dow double-acting vertical sinking pump. They operate in any position, whether suspended from the ringbolt attached to the steam cylinder head, hanging on timbers by means of the adjustable dogs founded for the purpose, or placed horizontally. The plunger barrel easily removed for substitution. A peculiarity of this pump is the suction condensers, the utility of which is an important consideration in sinking a shaft, as it not only consumes exhaust steam, avoiding the use of exhaust pipes leading out of the mine, or the damaging effect on the timbering if allowed to escape into the shaft, but is so constructed as to increase the efficiency of the pump by doing more work with a given amount of steam. A large one of this style was put in the Alaska Mine, Sierra County, not long since, to drain a flooded shaft which the other steam pumps were unable to do. A rig of this kind answers very well and its first cost is not great.

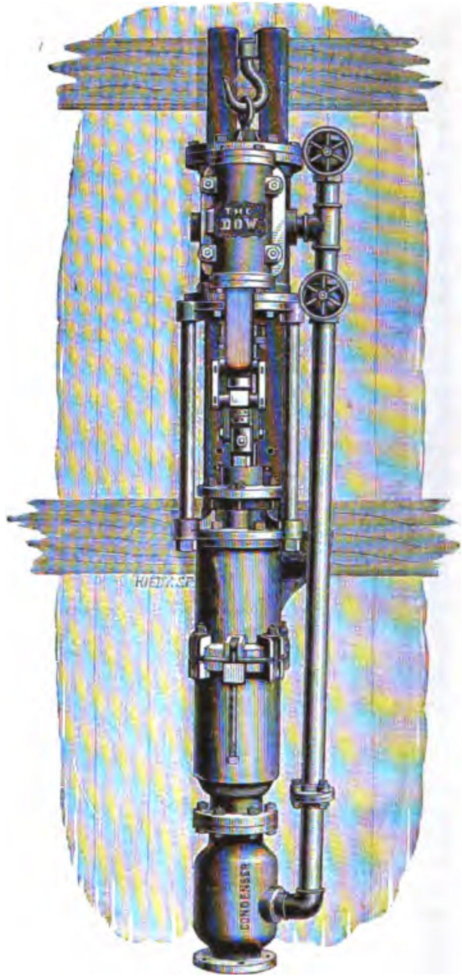
A recent application to vertical pumps of this class, by Mr. James E. Dow, of San Francisco, is a governor, so that if the water is lowered so air gets in, the pump cannot "run away" and be damaged. This new feature is an important one. With speed governor, and suction condenser, this type of pumps is greatly improved. None of these attachments are complicated, and may be managed by any ordinary mechanic. These and other improvements are overcoming former objections, and the modern "sinker" is a very convenient appliance. The engravings show two views.

To give an idea of the data and prices of such pumps, the following table is appended:

Steam Cylinder.	Bucket.	Plunger.	Stroke.	Gallons per Stroke.	Capacity per Minute at Ordinary Speed.
6½	6	4¼	10	.61	100 strokes, 61 gallons.
8	6	4¼	10	.61	100 strokes, 61 gallons.
10	7	5	12	1.02	100 strokes, 102 gallons.
10	8½	6	12	1.47	100 strokes, 147 gallons.
12	8½	6	12	1.47	100 strokes, 147 gallons.
12	10	7	18	3.00	60 strokes, 180 gallons.
14	10	7	18	3.00	60 strokes, 180 gallons.
14	12	8½	18	4.42	60 strokes, 265 gallons.
16	12	8½	18	4.42	60 strokes, 365 gallons.
18	12	8½	18	4.42	60 strokes, 265 gallons.
18	14	10	24	8.16	50 strokes, 408 gallons.
20	14	10	24	8.16	50 strokes, 408 gallons.

Sizes of Pipes.				Space Occupied.	Weight.	Price.
Steam.	Exhaust.	Suction.	Delivery.			
1	1½	4	2½	17 × 20 × 74	850	$450 00
1¼	2	4	2½	17 × 21 × 74	900	475 00
1½	2	4	3	20 × 24 × 82	1,500	650 00
1½	2	5	4	23 × 26 × 82	1,900	700 00
2	2½	5	4	23 × 28 × 82	2,200	775 00
2	2½	6	5	27 × 29 × 122	3,000	900 00
2½	3	6	5	27 × 32 × 122	3,400	1,000 00
2½	3	8	6	29 × 33 × 122		
2½	3½	8	6	29 × 34 × 124		
3	4	8	6	29 × 36 × 124		
3	4	10	6	33 × 39 × 150		
3½	4½	10	6	34 × 40 × 150		

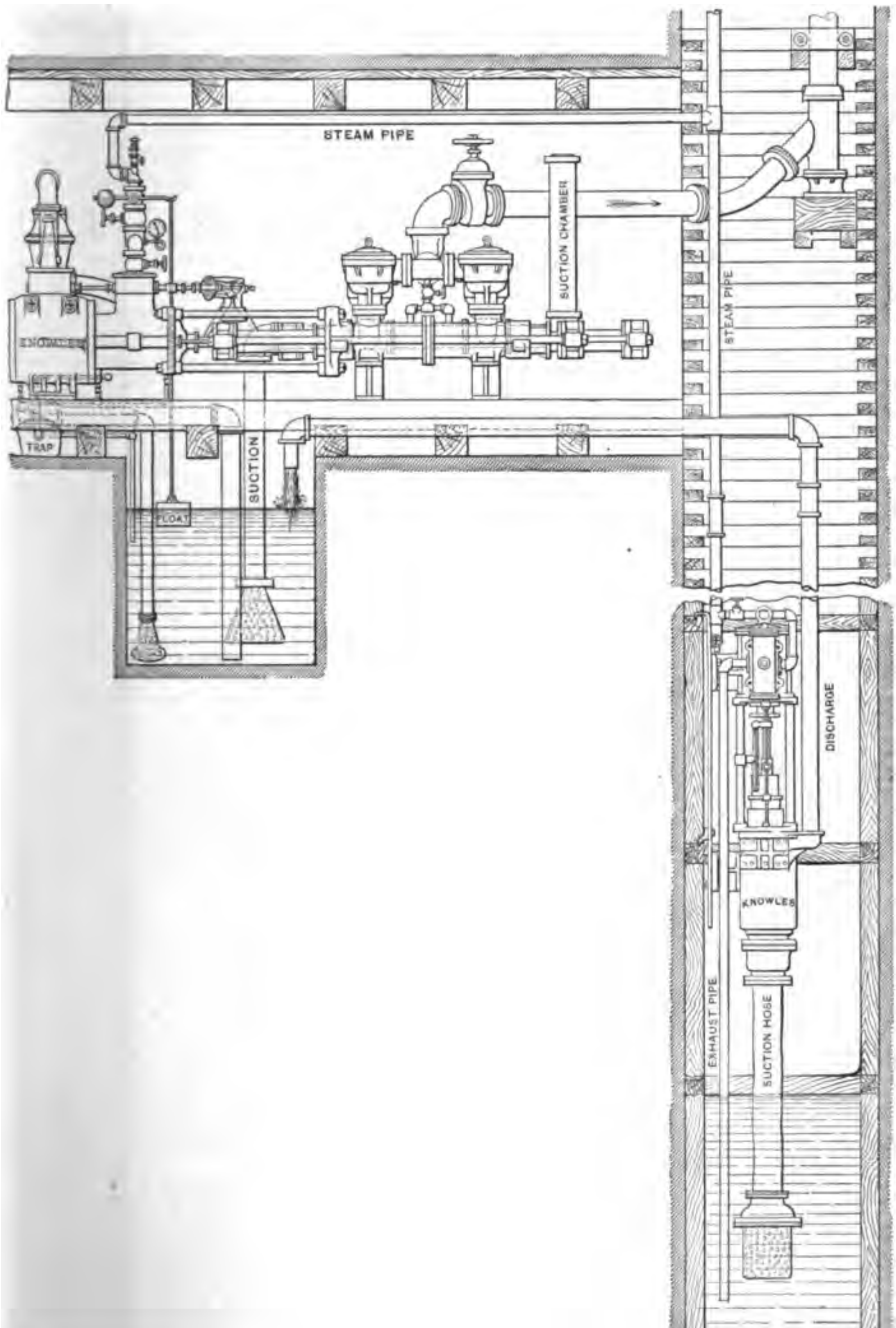
Side View.



Suction Condenser Attached.

VERTICAL DOUBLE–ACTING SINKING PUMP.

As illustrating the application of ordinary steam pumps to mines a sketch is here given showing a pumping station with the cistern, pumps, etc., the sinking pump being shown in the bottom of the shaft, where the suction hose extends into the shaft. The steam is brought down in jacketed pipes to operate the sinking pump, which takes the water up to the cistern in the station where the horizontal plunger pump is placed. This is operated, as the diagram shows, lifting the water from the cistern in the station to another similiar station above, where another pump is placed, or directly to the surface or point of discharge, according to height. In these Knowles pumps the exhausted steam is condensed by the water in the sump or cistern, as the pipes show; but recently another condensing feature has been attached. Many mines on this coast are provided with this sort of pumping rig.



Position of Station and Sinking Pump in Shaft.

In the very deepest mines on this coast, such as those on the Comstock, Nevada, it was found the weight of the pit work became so enormous that finally the rate of speed, which is determined by the weight of the mass set in motion, had to be decreased beyond all practicable working limits. The question then presented itself: What system of pumping can be adopted that will meet all difficulties that are ever present where heavy pumping works have to be constructed, and also meet the peculiar difficulties to be encountered in developing the great gold and silver bodies of ore in the Sierras? When the hydraulic system was suggested it was at first condemned, owing to the fact that it had never been tried, except in Europe, where mines of small depths had been drained. Finally, however, the managers of the Combination shaft decided to try it, and since then it has been successful on the Comstock, and several plants have been built.

The general plan of this system will be rendered plain to the reader by the accompanying drawings, and the following description, written by Robert S. Moore of the Risdon Iron Works, San Francisco:

By referring to the drawings of the general plan, it will be seen that the mine to which this system is applied, is 2,400 feet deep; also, that the water to be pumped is to be raised from the 2,400 level to a height of 800 feet and discharged into the Sutro Tunnel, through which it is run off. Upon the 2,400 level is erected a pair of hydraulic pumping engines (marked *P* in the drawing), which receive their pressure water through supply pipes from the surface. By these two pumps (as will be fully explained hereafter) the drain water is raised through discharge column to the Sutro Tunnel, and the water used in doing the work of pumping is sent back through the return pipe to a reservoir, *N*, on the surface. Upon the surface there is a cast-iron accumulator, *A*, which is 60 feet high and 25 inches in diameter. In this accumulator there are but 20 feet of water, the remaining space being occupied by air.

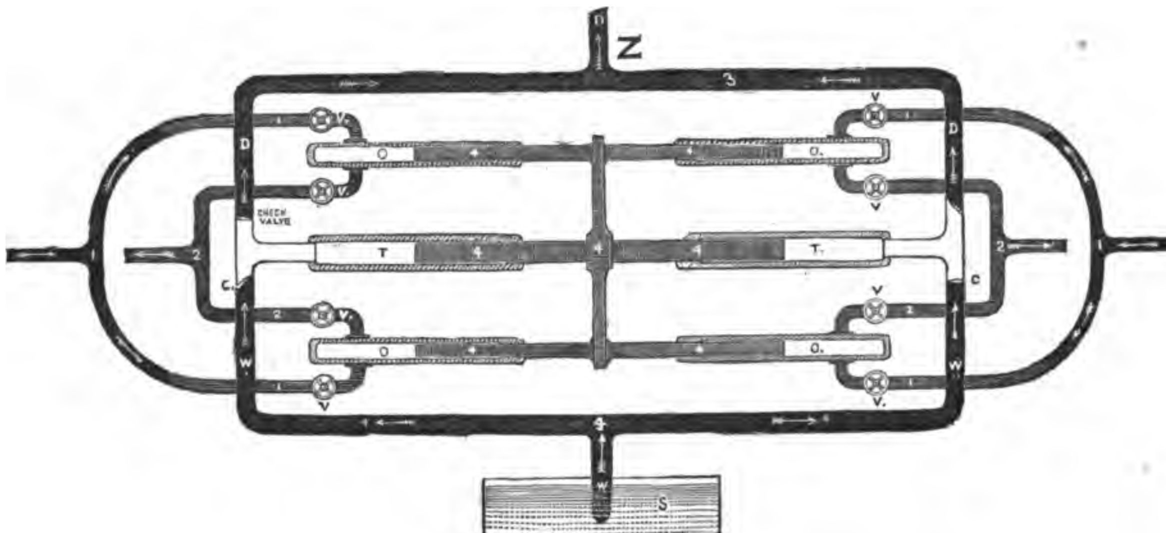
This air is kept constantly at a certain pressure by means of plunger pumps, *T*, which in turn are operated by a compound steam engine, *O*. These pumps, which supply the accumulator with water and keep it at a pressure great enough to run the two underground pumps, *P*, take their suction from the reservoir, *N*, into which the return water is discharged.

Now, since this pipe which supplies the pumps, *P*, is of such great length, and moreover, since the whole mass within it must be put in motion and brought to rest again during each stroke of the pumps, *P*, it is evident that some mechanical contrivance must be introduced for the purpose of lessening the jar in the pipes caused by the sudden stoppage of such an immense mass of water. The arrangement by which this end is accomplished, will be readily understood by referring to the drawings. It is constructed as follows: Let *E* (in general plan) be the valve which shuts off supply water from *P*. Close to the underground pumps there are firmly fixed two cast-iron cylinders, *C* and *C*, in which the plungers, *L*, *M*, carrying the crosshead, *D D*, are free to move. On either side of the arm, *D D*, are strong springs, *S*, *S*, held in position by the abutments, *B*, *B*. Now, when water in supply and return pipes is at rest, the arm, *D D*, is exactly in the middle between the cylinders, *C* and *C* (since the plungers, *L* and *M*, are so proportioned that the total pressure on *L* is precisely equal to total pressure on plunger, *M*). But after the underground pump, *P*, has completed its stroke, and the total mass of water in the supply pipe has to be brought from a velocity$=v$ to a velocity equal to zero, the inertia of this mass (due to velocity v) is supposed to be gradually reduced to zero by the plunger, *L*, *M*, being forced (on account of extra pressure on *L*) over to the right side. The distance it travels to the right depends, of course, upon the extra pressure produced by checking the velocity of supply water, and also upon the strength of the springs, *S*, which begin to be compressed as soon as *L M* begins to move. Now, after the crosshead has been forced over by this extra pressure to its maximum extent (the water in the three columns also coming to rest at this moment), the compressed springs, *S*, will immediately react to place the crosshead and plungers in their central position, ready to again take up the inertia of the mass in supply column on the return stroke of the pumps.

Thus, the object of these springs, *S*, *S*, is not only to assist the water in the return column in taking up the inertia of the water in the supply column, but chiefly to replace the plungers, *L*, *M*, in their central position after the masses in the three columns have come to rest.

The general arrangement of the system having been described, an account will now be given of the manner in which the work is performed by the pumps, *P*. In the drawing I have shown in detail that portion of the undergound pumps lying between the lines, *B* and *B*, on the general plan, leaving out, of course, that portion already explained for taking up the inertia of the supply water.

There are two of these underground pumps, situated on the 2,400 level of the mine, but since they are similar and work independently of each other, it is necessary to describe but one of them. They both take their supply water through the valve, *E*. Acting inde-



HYDRAULIC SYSTEM OF DRAINING MINES.

pendently, as they do, they will not necessarily commence and finish their strokes at the same time. But, in order to discuss the system under its extreme conditions, I will consider the two pumps as working together, thereby making the velocity of the supply water and the inertia of the moving masses a maximum.

Therefore, in each pump, let *O*, *O*, and *O*, *O*, see detail drawing, be the four pressure cylinders, and *T* and *T* the pump cylinders for raising the drain water to the Sutro Tunnel. Let *V* and *V* be the valves leading to the pressure cylinders from the supply and return pipes, and let the plungers be connected with a crosshead (as shown in drawing), so that when any movement of the plunger, *O O*, takes place, the plunger, *T T*, will be carried along also.

Now, let us follow the operation of these pumps, first assuming, however, that the pressure of the water in the supply pipe is great enough to produce motion of the plungers, *O*, *O*.

First, suppose the valves, *V*, to be opened (valves, *V*, remaining closed). The two plungers, *O O*, will be forced over to the right, carrying with them the larger plunger, *T T*. While *T* travels to the right, the space left by it is immediately filled with drain water coming through the suction pipe, *W*. Now, suppose valves, *V*, be closed and the stroke finished, the valves, *V*, are then opened, and the pressure of the supply water against the plungers, *O*, forces them to the left, and the water remaining in cylinders, *O*, is forced through the valves, *V*, into the return pipe, and thence into reservoir, *N*, upon the surface. At the same time, the water which was drawn into cylinder, *T*, on preceding stroke, is now forced (on account of the check valve, *C*, closing) through *D* into discharge column, *D*, and thence 800 feet into the Sutro Tunnel. Again, while this stroke to the left is being made, the space left by plunger, *T*, is being filled with drain water through suction pipe, *W*. At the completion of this stroke, valves, *V*, are closed and valves, *V*, are opened, the crosshead and plungers again move to the right, and the waters remaining in the cylinders, *O*, is again forced through return column into reservoir, *N*. At the same time, the water in cylinder, *T*, is forced upward (on account of check valve, *C*, being closed) through *D* into *D*, and thence to Sutro Tunnel. When crosshead and plungers are again over to the extreme right, valves, *V*, are closed and valves, *V*, opened, and thus the operation continues, the valves, *V* and *V*, being worked automatically by means of tappets carried by the crosshead. The number of strokes made by these pumps evidently depends upon the pressure of water in the supply pipe, and also upon the rapidity with which the valves, *V* and *V*, are opened and closed.

In the preceding, I have followed the action of but one underground pump, but, as I have said before, the two are alike in every respect, and both draw their water from and discharge it into the same columns.

From the above remarks, it will be seen that the sole object of these two underground pumps is to raise the drain water from the 2,400 level of the mine to the Sutro Tunnel, a distance of 800 feet. The object of the accumulator, *A*, upon the surface, is to accumulate the water within it, under a pressure great enough to work the pumps, *P*, and the object of the compound steam engine and pumps, *T* (on the surface), is to supply the accumulator with exactly the same amount of water taken from it, to run underground pumps. Furthermore, it will be noticed that the same amount of water which is used to run these pumps, *P*, is returned to reservoir on the surface, from whence it is forced into the accumulator by pumps, *T*, to be used over and over again.

Right here it might be well to mention the fact, that the surface pumps, *T*, were constructed with a capacity great enough for two more pumping engines, similar to those just described (*P*), so that when a depth of 1,000 feet more was reached, this extra set of pumps would be put in at the 3,400 level, and the process go on as before.

The above description, by Mr. Moore, explains the action of the hydraulic pumps on the Comstock. Since it was written the pumps have been running several years, and the springs (marked *S* on the diagram) have been replaced by air chambers, so that the concussion of water lost in discharge, pressure, and return columns, has been overcome by means of air chambers erected on the same station with the pumps. It was found impossible to properly regulate the springs to work as efficiently as the air chambers have done. The population of Virginia City decreased so rapidly that the water company were enabled to supply the Combination Shaft with water to run their pumps. Instead of the accumulator and surface engine being required, they were only kept as a reserve in case of a failure of the water supply. After the shaft had been sunk considerably in depth, two more pumps were added on the 2,600-foot level, and later on two extra additional ones at the 3,000-foot level, which raised 4,000,000 gallons of water daily to the Sutro Tunnel, a direct lift of 2,400 feet of hot water, at a temperature of 140 degrees. In all there were six pumps, which have been running constantly, without a single stop, this last number of years. It is

only in October last that they were shut down, by order from the companies, because deep prospecting was found unprofitable. They are now submerged in several hundred feet of water. The Risdon Iron Works have built several other pumps on this same style, and all have worked successfully. These pumps have lately been introduced in England, at some large collieries there, and are also working satisfactorily.

WEIGHT OF QUARTZ MILLS.

As many miners have no information of the details of weight of the parts of quartz mills, the following statement concerning five, ten, and twenty-stamp gold mills has been obtained from the Joshua Hendy Machine Works, San Francisco. Of course the weights of the ore-feeders and the concentrators depend upon the pattern used, but the figures given will afford a basis upon which miners can estimate what freights have to be paid.

MEMORANDA OF WEIGHTS OF FIVE-STAMP QUARTZ MILL (GOLD).

Rock-breaker	4,500 lbs.
Ore feeder ("Challenge")	750 lbs.
Mortar, for 750-lb. stamps	4,000 lbs.
Dies, 100 lbs. each, five	500 lbs.
Shoes, 110 lbs. each, five	550 lbs.
Stems, 340 lbs. each, five	1,700 lbs.
Bossheads, 200 lbs. each, five	1,000 lbs.
Tappets, 100 lbs. each, five	500 lbs.
Cams, 150 lbs. each, five	750 lbs.
Cam shaft	350 lbs.
Concentrators ("Triumph"), 2,275 lbs. each, two	4,550 lbs.
Clean-up pan	800 lbs.
Revolving barrel	1,200 lbs.
Batea	200 lbs.
Retort	75 lbs.
For pulleys, piping, belting, bolts, etc.	2,400 lbs.
Total	23,825 lbs.

MEMORANDA OF WEIGHTS OF TEN-STAMP GOLD QUARTZ MILL.

Rock breaker	5,200 lbs.
Ore feeder ("Challenge") 750 lbs. each, two	1,500 lbs.
Mortar for 750-lb. stamps, 4,000 lbs. each, two	8,000 lbs.
Dies, 100 lbs. each, ten	1,000 lbs.
Shoes, 110 lbs. each, ten	1,100 lbs.
Stems, 340 lbs. each, ten	3,400 lbs.
Bossheads, 200 lbs. each, ten	2,000 lbs.
Tappets, 100 lbs. each, ten	1,000 lbs.
Cams, 150 lbs. each, ten	1,500 lbs.
Cam-shaft, 13′ 6″x4′ 1″	700 lbs.
Cencentrators ("Triumph"), 2,270 lbs. each, three	6,810 lbs.
Clean-up pan	800 lbs.
Revolving barrel	1,200 lbs.
Batea	200 lbs.
Retort	100 lbs.
Pulleys, piping, belting, bolts, etc.	5,300 lbs
Total	39,810 lbs.

MEMORANDA OF WEIGHTS OF TWENTY-STAMP GOLD QUARTZ MILL.

Rock-breaker	10,300 lbs.
Ore-feeder ("Challenge"), 750 lbs. each, four	3,000 lbs.
Mortar for 800-lb. stamps, 4,500 lbs. each, four	18,000 lbs.
Dies for 800-lb. stamps, 125 lbs. each, twenty	2,500 lbs.
Shoes for 800-lb. stamps, 120 lbs. each, twenty	2,400 lbs.
Stems for 800-lb. stamps, 360 lbs. each, twenty	7,200 lbs.
Bossheads for 800-lb. stamps, 210 lbs. each, twenty	4,200 lbs.
Tappets for 800-lb stamps, 110 lbs. each, twenty	2,200 lbs.
Cams for 800-lb. stamps, 165 lbs. each, twenty	3,300 lbs.
Cam shaft	1,700 lbs.
Clean-up pan	1,000 lbs.
Revolving barrel	1,400 lbs.
Batea	200 lbs.
Retort	300 lbs.
For pulleys, belting, piping, bolts, etc	12,600 lbs.
Total	70,300 lbs.

The Pacific Iron Works of San Francisco also furnish data to this report on both silver and gold mills, as follows:

TEN-STAMP FREE ORE SILVER MILL.

One 4 feet by 12 feet grizzly.
One 8 by 10 Blake crusher.
Two automatic ore feeders.
One 10-stamp battery, 750 to 800 pound stamps.
Four 5-foot combination amalgamating pans.
Two 8-foot settlers.
One 3-foot clean-up pan.
One amalgam safe and strainer.
One quicksilver elevator, with tanks, pipes, etc.
Two traveling crabs for battery and pans.
One 14-inch silver retort.
One melting furnace.
Shafting, pulleys, boxes, etc., for mill.
Belting for mill.
Pipes and fittings complete.
One Duncan concentrator for saving quicksilver and amalgam.
Weight of the above, 87,000 pounds.

Power required:
One 50-horse power engine.
One 50-horse power boiler.
One 50-horse power feed-water heater.
One No. 3 steam pump.
Steam and water connections.
Weight of the above, 24,500 pounds.
Total weight of the above, 111,500 pounds.

TWENTY-STAMP FREE ORE SILVER MILL.

One 4 feet by 12 feet grizzly.
One 8 by 10 Blake crusher.
Four automatic ore feeders.
Two 10-stamp batteries.
Eight 5-foot combination pans.
Four 8-foot settlers.
One 4-foot clean-up pan.
One quicksilver elevator, with tanks, pipes, etc.
Three traveling crabs and track for batteries and pans.
Two amalgam safes and strainers.
Two 14-inch silver retorts.
One melting furnace.
Shafting, pulleys, boxes, etc., for entire mill.
Belting for entire mill.
Pipes and fittings for mill.
One Duncan concentrator, for saving amalgam and quicksilver.
Weight of the above, 180,000 pounds.

Power required:
One 100-horse power engine.
Two 50-horse power boilers.
One 80-horse power feed water heater.

One No. 4 steam feed pump.
Steam and water connections.
Weight of the above, 50,000 pounds.
Total weight of the above, 230,000 pounds.

Grizzly, 4 feet by 12 feet, weighs about 2,000 pounds.
8 by 10 Blake crusher weighs about 8,000 pounds.
Automatic feeder weighs about 700 pounds.
Battery, ten stamps, weighs about 27,000 pounds.
5-foot pan, combination, weighs about 6,200 pounds.
8-foot settler weighs about 6,000 pounds.

TEN-STAMP GOLD MILL.

One grizzly, 4 feet by 10 feet.
One 8 by 10 Blake crusher.
Two automatic ore feeders.
One 10-stamp battery, 750 pound to 800 pound stamps.
One traveling crab for battery.
Sixty square feet of silver-plated copper plate, No. 14 gauge, plated 1 ounce of silver to the square foot.
Shafting for mill.
Battery, pipes, and fittings.
Belting for mill.
One gold retort.
Weight of the above, 37,500 pounds.
Power required:
One 25-horse power engine.
One 30-horse power boiler.
One 20-horse power feed water heater.
One No. 2 steam pump.
Steam and water connections.
Weight of the above, 10,500 pounds.
Total weight of the above, 48,000 pounds.

TWENTY-STAMP GOLD MILL.

One grizzly, 4 feet by 12 feet.
One 8 by 10 Blake crusher.
Four automatic ore feeders.
Two 10-stamp batteries, 750 pound to 800 pound stamps.
Two traveling crabs for batteries.
One hundred and twenty square feet silver-plated copper plates, No. 14 gauge, plated 1 ounce of silver to the square foot.
Shafting for mill.
Battery pipes and fittings.
Belting for mill.
One gold retort.
Weight of the above, 72,000 pounds.
Power required:
One 50-horse power engine.
One 50-horse power boiler.
One 50-horse power feed water heater.
One No. 3 steam pump.
Steam and water connections.
Weight of the above, 24,500 pounds.
Total weight of the above, 96,500 pounds.

TWENTY-STAMP GOLD MILL.

Many communications having been received by the State Mineralogist for component parts of gold mills, he deemed it advisable to publish in his report the following specifications, kindly furnished to Trustee W. S. Keyes, E.M., by J. Hamilton:

SPECIFICATIONS OF TWENTY-STAMP GOLD QUARTZ MILL FOR THE BUCHANAN MINE, TUOLUMNE COUNTY, CALIFORNIA.

One (1) *Grizzly*, to be made of ¾-inch by 2½-inch wrought iron, 12 feet long, 4 feet wide; spaced 2 inches between the bars, and secured by three ¾-inch bolts, and cast-iron thimbles and washers; also end bars.

Rock Breaker.—One Blake crusher, fitted with two flywheels, 4 feet in diameter, and one (1) pulley, 30 inches in diameter, and 12-inch face crank-shaft, to have out-board bearings; holding-down bolts for each, to be long enough for 14-inch timbers; all caps for boxes to be fitted to use zinc oil cups, and "Albany" lubricating compound.

Battery.—Four (4) single discharge gold mortars, each weighing about 5,000 pounds; the bottoms to be 6½ inches thick; well planed; the screw frame bearings to be planed also; the bases to be 26 inches wide, 3 inches thick, and cored for eight (8) mortar bolts 1½ inches in diameter; the feed mouth to be 26 inches long and 3½ inches wide, at the smallest part; the mortars to be well finished, and to be 56 inches long, and about 52 inches high.

Mortar Bolts.—Thirty-two (32) mortar bolts, 1½ inches in diameter, and 36 inches long; nuts on both ends, and thirty-two (32) 4-inch square countersunk washers for the lower ends; one (1) wrought-iron wrench; jaw designed for the nuts of mortar bolts; arm to be 6 feet long, slightly curved, made of 1-inch by 2½-inch iron.

Stamp Dies.—Stamp dies, 7 inches deep, 8½ inches in diameter, with square bases, having beveled corners, and all made to properly fit the mortars, and to be cast of the best car-wheel iron; stamps to weigh 850 pounds each.

Shoes.—Twenty (20) stamp shoes, 8½ inches in diameter, 7½ inches long; to be cast of the best car-wheel iron.

Heads.—Twenty (20) stamp heads, 8½ inches in diameter, 18 inches long; keyholes to be 1⅛ inches by 3 inches; one (1) key for driving out shoes and stems, and to be made as may be directed.

Tappets.—Twenty (20) double-faced gib tappets, made of the best steel faces, 9 inches in diameter; tappets to be 12 inches long; bands or flanges turned, and each to have gibs and three (3) steel keys, and all to be marked; keys to be boxed for shipment.

Cams.—Twenty (20) double-armed cams, made of best steel; ten (10) to be right, and ten (10) to be left-handed; hubs on one side, and to be strongly banded with ⅝-inch by 2-inch wrought-iron bands, well shrunk on; the faces of the cams to be well smoothed, and to be fitted to 5½-inch cam shafts, and to be properly marked.

Feeders.—Four (4) Hendy Challenge ore feeders, complete with all latest improvements; also, twenty (20) steel keys for same, to be marked and fitted, and properly boxed for shipment; the cams to be about 32 inches long, with 2½-inch face, and struck to give an 8½-inch drop if required.

Corner Boxes.—Six (6) corner boxes, for 5½-inch cam shafts; cored for 1-inch bolts; backs to be planed true, and bearings to have a strip running lengthwise, and the balance of the bearings to be well babbitted and bored; the ends to be faced; the cap to be solid, bored, but not babbitted, unless required, and bored with three (3) ⅝-inch holes each, for using "Albany" compound.

Cam Shafts.—Two (2) cam shafts, 5½ inches in diameter, and 14 feet 6 inches long, and key-seated between bearings.

Jack Shafts.—Four (4) jack shafts to be 3 inches in diameter and 59 inches long, with eight (8) bearings for same, and to be made of cast-iron.

Stems.—Twenty (20) stamp stems 3¼ inches in diameter, 14 feet long; turned and tapered off both ends for heads; made of rolled iron.

Latch-sockets.—Twenty (20) open latch-sockets; all to be well lined with heavy leather.

Guides.—Four (4) complete sets of best white oak guides. The lower guides to be 16 inches wide and 4 inches thick, and the upper to be 14 inches wide and 4 inches thick; bored for 3¼-inch stamp stems, and to be 10 inches between centers; all to be 60 inches long.

Cam-shaft Pulleys.—Two (2) wood pulleys, 72 inches in diameter, with 16-inch faces and 6-inch thickness of wood between the flanges, and to be made of the best kiln-dried sugar pine; to be turned and well bolted to 40-inch diameter cast-iron sleeves; flanges for 5½-inch cam shaft; the flanges to be faced.

All of the keys for this mill to be made of the best steel.

Overhead Crabs.—One (1) crab for battery having flanged wheels 7 inches in diameter and 2-foot face; the axles to be 1½ inches square and long enough to set the wheels 10 inches between the flanges; the boxes to be 1¼ inches thick, and all made of the best wrought iron.

Piping, etc.—All piping, hose, valves, bibs, cocks, ells, tees, unions, etc., to be furnished as per detailed bill. All necessary bolts, belts, nuts, and washers, also copper plate for battery and aprons, to be furnished of proper weight, and as shown on drawings, ⅛-inch thick, not plated; also, silver-plated copper plate, 20 inches wide and 20 feet long.

Belting—One (1) main driving belt, to be about 55 feet long, 20 inches wide, and made of the best 5-ply rubber of the "Boston Belting and Packing Co.'s" manufacture, patent stretched.

Battery Belts.—One hundred and ninety (190) feet of the best 5-ply rubber, 16 inches wide.

Rockbreaker Belt—Ninety (90) feet of 4-ply rubber, 12 inches wide.

Boxes for Shafting.—All boxes to be planed on the bottom and faced on the ends, and to be well babbitted, and the caps to be bored with ⅝-inch holes, for Tatum & Bowen's lubricating compound. Two (2) steel collars and set-screws for each.

Shafting and Pulleys.—One (1) main battery line shaft to be made in two lengths, 4 inches in diameter, 20 feet long, and 3½ inches diameter, 20 feet long, coupled together with solid coupling. One (1) countershaft for driving rock breaker, 3 inches diameter, 20 feet long; both shafts fitted with all necessary bearing boxes, and holding down bolts for 14-inch timbers.

Pulleys.—One (1) main driving pulley to be fitted to engine crank shaft at mine, to be 48 inches diameter, 21-inch face.

One (1) pulley for main battery line shaft, to be 72 inches diameter, 21-inch face, 4-inch gauge.

One (1) pulley to drive crusher countershaft, 40 inches diameter, 12½-inch face, 4-inch gauge.

One (1) pulley to drive battery, 34 inches diameter, 16½-inch face, 3½-inch gauge.

One (1) pulley to drive crusher, about 40 inches diameter, 12½-inch face, 3-inch gauge.

One (1) pulley on crusher countershaft, 26 inches diameter, 12½-inch face, 3-inch gauge.

Tighteners.—Two (2) battery tighteners, 16 inches diameter, 20-inch face, with racks, pinions, frames, hand-wheels, pawls, and pawl plates, complete for stopping and starting the batteries.

One (1) rock breaker tightener complete, as above specified, for stopping or starting the crusher.

All necessary bolts for batteries and building, and all necessary belt rivets for securing the belts. All belting used in this mill to be of Boston Belting Co.'s manufacture, best quality and patent stretched.

All castings to be made of good material, smooth and free from blow-holes or other imperfections. All keys to be made to fit and properly marked.

Mortars are to be cast from selected patterns or drawings, which will be furnished.

Should anything be lacking to complete this mill which has not been specified, it must be supplied the same as if fully mentioned.

Everything to be delivered on the ground (at company's expense), and timbers to be cut according to plans to be supplied.

NOTE.—The company already had an engine and boiler. The building, also, over the mill was built by the company. The cost of the above material was $5,985, and of the labor, $2,300. Save a slight change in the tappets, the work was satisfactorily done, and the mill crushed over two tons per stamp, of hard quartz, every 24 hours.

The total cost of grading, building, machinery, etc., was a little short of $15,000.

CONCENTRATION OF GOLD AND SILVER ORES ON THE PACIFIC COAST.

(By J. M. ADAMS, E.M.)

This article is based entirely upon the practical experience of the writer, who, since first becoming connected with the mining interest, has ever sought to draw attention to the great importance of a correct system of concentration.

In 1867 he came to California, en route to Silver City, Idaho, where he was engaged for some time in mining and milling the ores of gold and silver.

As a part of his studies in the Mining School, of which he is a graduate, he labored over Rittinger's Aufbereitenskunde, and obtained from it a fair book knowledge of the dressing and concentration of ores, as practiced in Europe. But the conditions are so different in this country, labor is so much higher, etc., that he has found the appliances advocated by Rittinger of but little benefit, as for example:

Mr. Liebenan, a bright, intelligent, and industrious young German, who had graduated from Freiburg, consumed a large part of the year 1867 endeavoring to concentrate economically with shaking tables, etc., the ores of Flint District, about eight miles from Silver City, Idaho.

The mineral present at the ores was largely tetrahedrite, or gray copper ore, containing a high percentage of silver, the gangue being a hard white quartz. Mr. Liebenan, however, failed, partly because the German method required so much labor, which was very high in Idaho; still he obtained a fair percentage of the mineral in high grade concentrations, and would probably have made a success, if he could have used the perfect automatic concentrators now in use in the mining sections of the United States. As it was, Liebenan failed, and drifted away to other fields, finally dying, poor fellow, in the prime of life, in Venezuela.

In one of the mills at Silver City, of which the writer had charge, he attempted to save part of the loss in the tailings with Hungerford concentrators and Evans' corrugated riffles, using them below the agitators, but he found the uneven discharge and varying proportion of sand and water so injurious, that satisfactory results could not be obtained; furthermore, neither were very effective appliances for saving sulphurets.

He used siphons and other means to draw from the agitators, in the endeavor to obtain uniform supply for the concentrators, but all that was saved was a little quicksilver and amalgam, not enough to pay for the wear and tear of the Hungerfords, which are similar to the Hendy concentrators, which are described on another page. The use of sluices with blankets also proved unsatisfactory.

In 1867 the writer stopped for a day at Grass Valley, where he found at the Eureka Mine, in successful operation, a "wonderful and secret process" for extracting the gold from the sulphurets, called "chlorination."

Sluices were being used below the mill to save the sulphurets. Concentration of ores is simply the separation of the heavy from the light, and is performed sometimes on dry ore, but generally water is used, especially in California, where it is practiced principally on the ores of gold and silver, which are either native or associated with, or part of various metalliferous minerals; the gold and silver, as well as the minerals, being much heavier than the gangue or vein matter in which they occur.

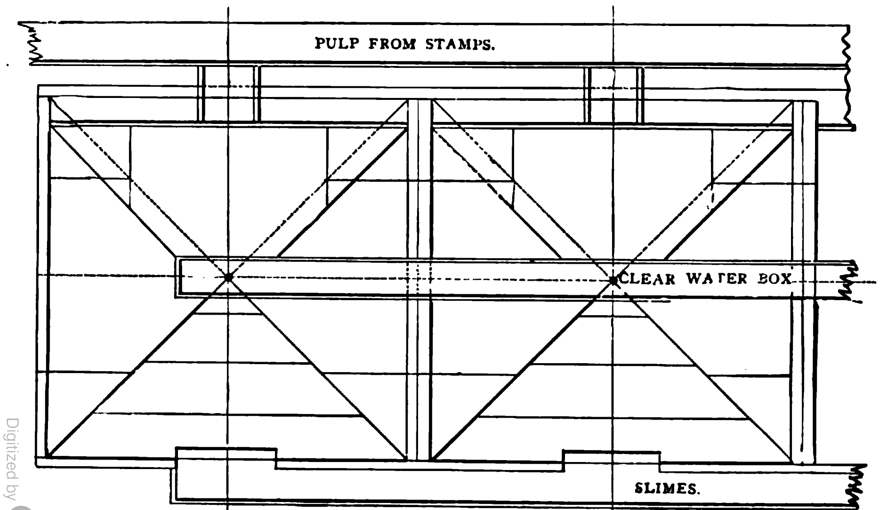
They are freed to a large extent from the gangue by crushing or pulverizing to a proper degree of fineness, and according, as the concentrating work is more or less perfect, the separation is made of the heavy or valuable part of the ore from the gangue. Occasionally the lightest—or finest—part of the crushed ore is very rich, and is worth saving by itself.

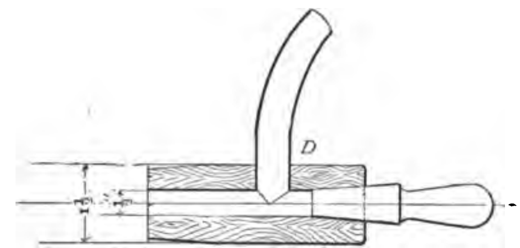
In dry concentration this is the dust, and is separated and saved if of sufficient value.

In wet concentration this light portion is the slime, and if rich enough to be saved the pulp is passed through a pointed box (as per cut and description below). The slimes pass off from the top, to be settled and saved, the balance discharging from the bottom to the concentrator, for separation and saving of the mineral.

In some cases it is preferable to put the pointed box below the concentrator, and thus separate from the tailings and save the rich slimes. As a rule, however, most of the money in the slimes exists as finely divided sulphurets, which are caught and saved with the balance of the sulphurets by the best concentrators, so that there then is only an occasional ore whose slimes need segregation and saving.

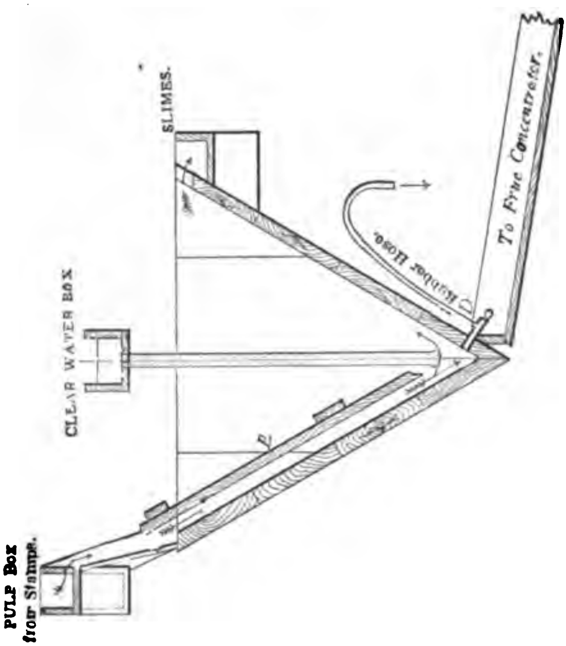
I have, however, deemed it best to give the following description and cut of the pointed box:

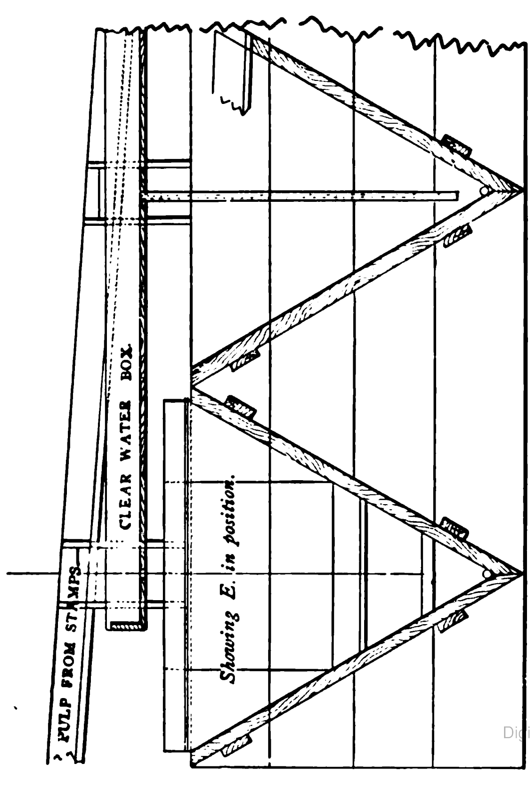




POINT BOX.

Scale, ½″ = 1′


PULP Box
from Stamps.
CLEAR WATER BOX
SLIMES.
Rubber Hose.
To Frue Concentrator.


PULP FROM STAMPS
CLEAR WATER BOX
Showing E. in position.

Several forms are in use. Their dimensions vary according to the duty required. In some cases it is desired to save and settle together all the pulp, including the slimes, when there is too much water present for subsequent concentration. In such event the pointed box should be about 6 feet deep, and 3 feet by 7 feet at the top, the longest sides sloping till they meet at the bottom.

Such a box will settle and save about six tons of ore in twenty-four hours, discharging it automatically and continuously from the bottom by a siphon hose, with the proper amount of water for subsequent concentration.

This form is used when the tailings from pan amalgamation are to be concentrated, after leaving the settlers and agitators, for they contain a large excess of water, which must be gotten rid of, so that the tailings are of the proper consistency for concentration.

The accompanying cut shows a form of point box used in cases where the slimes are to be separated from the pulp and saved. Each box is 40 inches square at the top, and 40 inches deep, coming to a point at the bottom; and one box will handle from 6 to 10 tons of pulp in twenty-four hours, making a good separation.

The pulp from the battery, entering the box at the top, is confined by partition *E*, until it passes into the box proper, near its bottom. Clear water is conveyed from above through a half-inch pipe, which delivers it into the box at the bottom. Care must be taken that this pipe is kept full, so that no air bubbles are carried through it, as they create agitation, and cause sand, etc., to pass off with the slimes.

The amount of clear water needed varies, so it is a good plan to have a cock in the pipe just below the clear water box, or else partially close, with a wooden plug, the opening of the pipe in the clear water box. At D is a hollow plug, and to it is attached a piece of hose, which is used as a siphon, so that the pressure is lessened and too violent discharge of the pulp is prevented.

Without the siphon hose, $\frac{3}{8}$ inches opening would not be too small, while with it $\frac{3}{8}$ inches opening is about right, and the end of the hose is plugged accordingly. Inasmuch as foreign coarse material occasionally gets into the box (prevented as much as possible by a screen over the top), it is advisable to use in place of the hollow wooden plug shown, a $1\frac{1}{2}$-inch iron tee with one end plugged, and with $\frac{3}{4}$ inch side outlet, attaching the siphon hose by nipple.

Thirty-five years ago, concentration in California consisted simply in saving the placer gold, and the appliances used were the rocker and sluice. Various grades were given to the sluice; its bottom was formed in various ways, some using plain riffle bars, some preferring blocks of wood sawed across the grain; others liked boards, full of round holes, undercurrent riffles, etc. Sometimes quicksilver was used to catch the gold; sometimes none was used.

When gold was discovered in quartz in California, and reduction works for the same were to be constructed, Californians knew nothing of the required means, and had to adopt the old square wooden stem Cornish stamp, the arrastra, etc., but with our ingenuity, native to Americans, improvements were rapidly made, and to-day American (United States) machinery for mining and reduction of gold and silver ores is the best in the world.

The old fashioned stamp was replaced by the round iron stemmed stamp, revolving as it is lifted by the cam, and with cams, tappets, shoes, and dies of cast-steel, the wear has been reduced to a minimum, and the

present standard American stamp mill is a very different crushing appliance from the clumsy stamps first used by us.

Most of the quartz veins worked in early days were either much decomposed on the surface, or were clean quartz containing the bright yellow gold. As depth, however, was attained, the decomposed ores changed, and sulphurets of iron and copper, with galena, blende, and other minerals, were found. The ore did not yield as much of its gold as the surface ore; there was some gold in the tailings, and further examinations showed that a large part of the loss was in the sulphurets, hence we began to realize that there was money in the sulphurets, and two problems arose:

First—How to save the sulphurets.

Second—How to realize the money contained in them after they were saved.

In regard to the second problem it was soon known, that if rich enough they could be sold to parties who would send them to ——, or other smelting works in Europe, while in some cases quite a proportion of the gold could be saved by thorough amalgamation in pans or barrels, and about 1867 it was proved that a high percentage of the gold could be profitably extracted from the sulphurets by roasting and chlorination.

As regards the first problem, "How to save these gold-bearing sulphurets," here the necessity of concentration became apparent, as the only economical method was by taking advantage of their greater weight and separating them accordingly.

Labor being very high, automatic concentrators became a desideratum, stimulating the inventive faculties of many who were engaged in mining. Various machines were devised and tested; most of them proved to be of little value, and the appliances in general use for saving sulphurets in California in 1875 were few in number, being as follows:

The sluice with blankets or burlaps.

The sluice with riffles and the buddle.

The raising gate.

The Hendy concentrator.

The grade of the sluice, using blankets or burlaps, was generally about ½ inch to the foot. A double set was used; the blankets or burlaps in one set being taken up and washed, while the other set was in use. By very frequent washings the sulphurets were obtained fairly clean, but this took so much labor that they were seldom washed, and the ordinary product contained much sand, and the sulphurets contained were coarse, the finer sulphurets passing off, although nearly equal in quantity and frequently much richer than the coarse sulphurets.

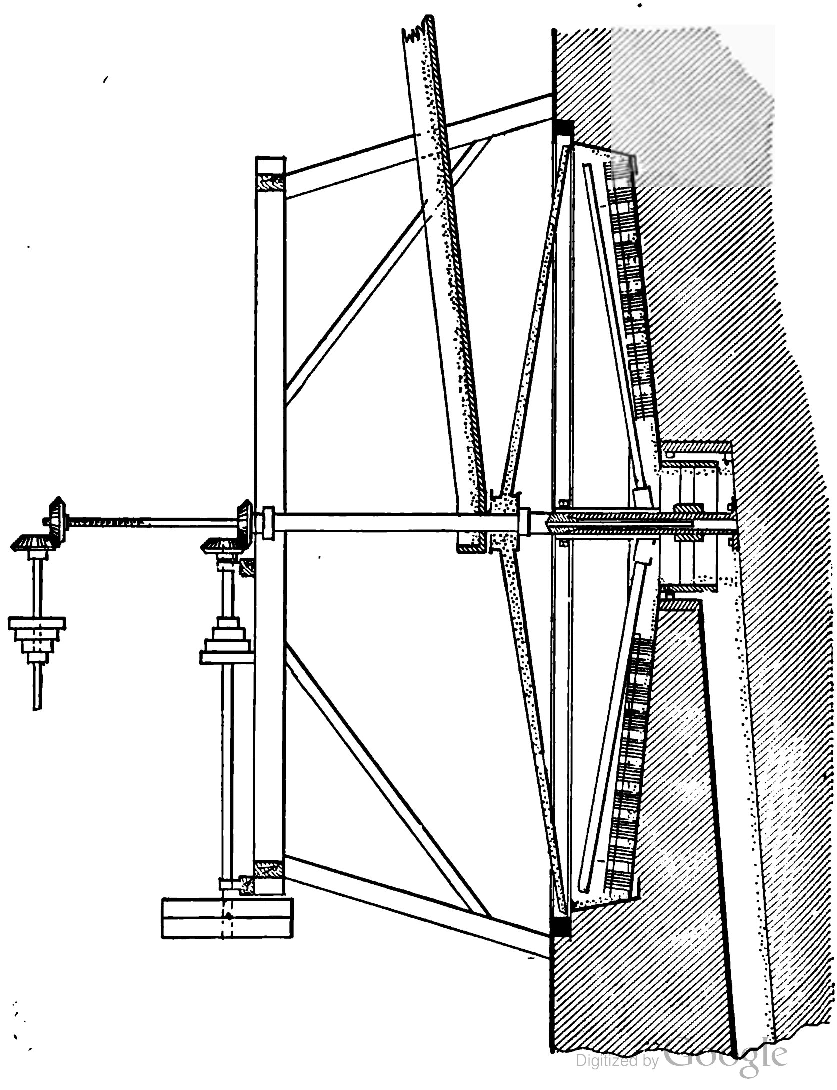
The grade of the sluice with riffles was about ¾ inch to the foot, and was generally of the following type: Two sets are used; each riffle is formed by a half-inch strip of wood, fitting across the sluice, and about ten feet from the next riffle. At stated periods, according to the amount to be collected (varying in different ores), another strip is placed on top of the previous one, and this is continued until the sluice is nearly full at each riffle, when the tailings from the mill are turned into the other set of sluices for similar treatment, and the material accumulated in the first set of sluices is collected, and further concentrated in a buddle, of which there are several styles.

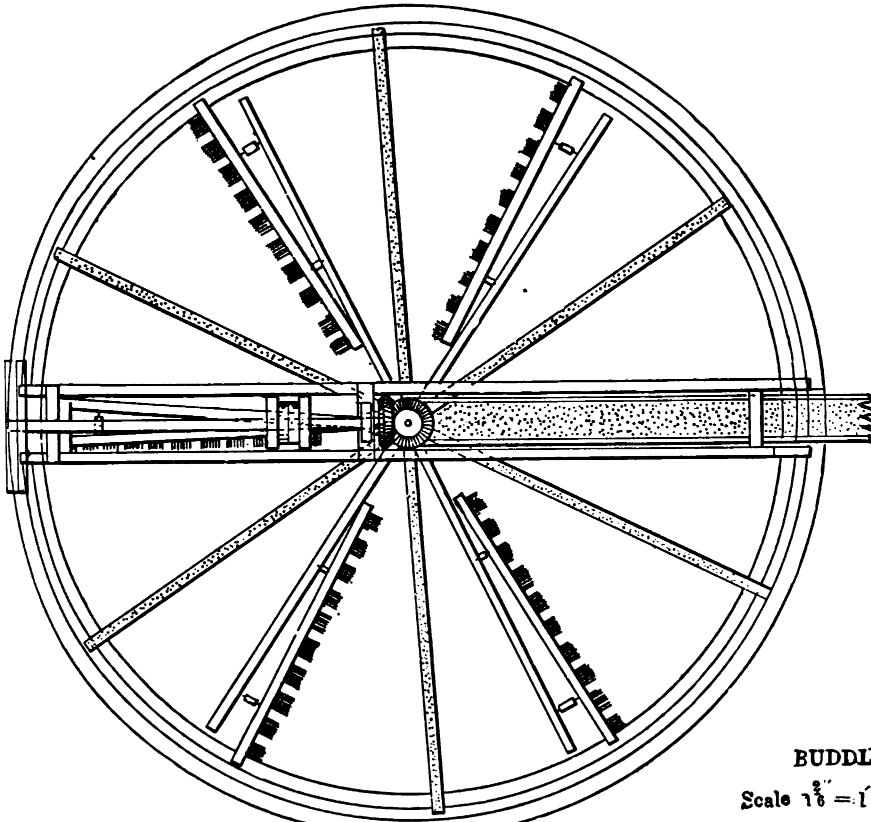
The accompanying cut shows one used frequently, and may be described briefly, as follows: It is circular, with concave bottom, and the discharge for the tailings is in the center, where there is a hollow iron cylinder, shown in the cut, with its top or rim even with the bottom of the buddle. In this position everything will flow out of the buddle, but this ring or

cylinder is attached to an upright spindle and by the gear at the top is gradually raised, retaining in the buddle the sulphurets as they accumulate, and constantly raising the discharge of the tailings; the arms, also, from which the brushes hang, are gradually raised at the same time by the mechanism.

The material to be buddled is delivered from above the center through six pipes at the periphery of the buddle. Very little water is used, and there is no agitation except that made by the brushes, which are constantly moving around the circle, resting on the pulp, and being dragged around by the arms.

By means of the step pulleys above, the gradual raising of the discharge cylinder and of the brushes are regulated as required for the material operated on. When the buddle is full of sulphurets, it is stopped and cleaned out.



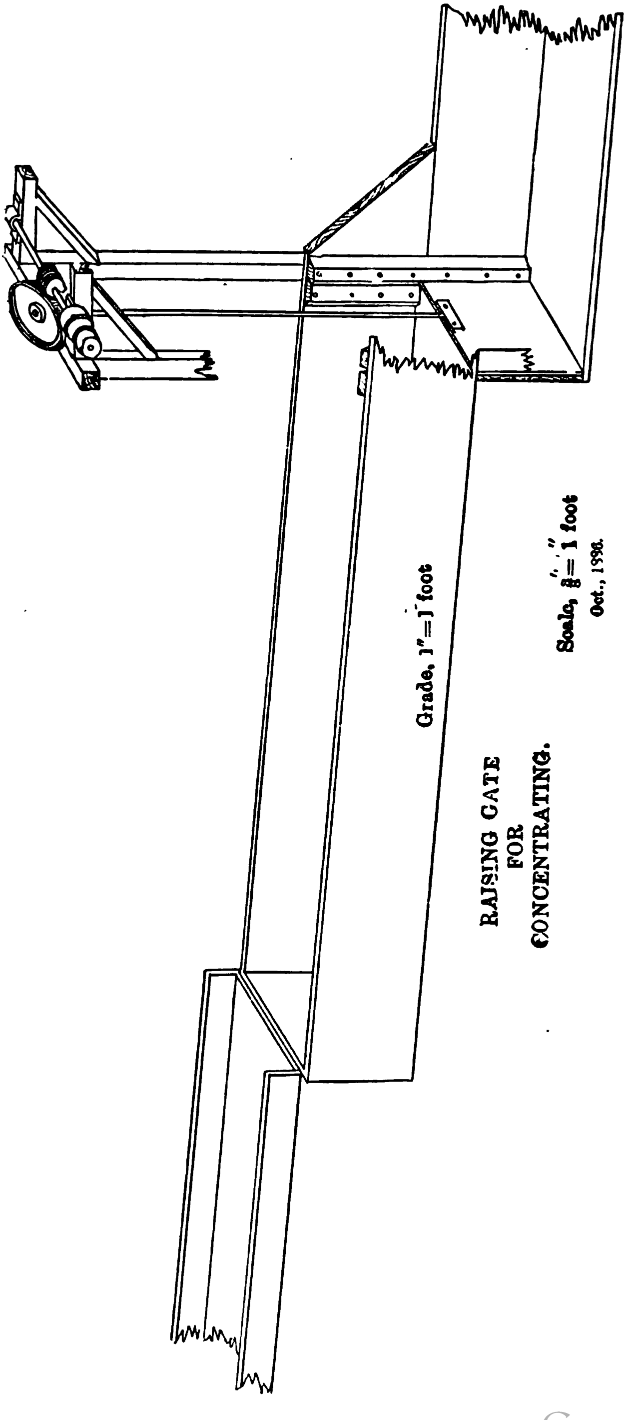


BUDDLE

Scale $\frac{2}{16}'' = 1'$

This system of sluice with riffle and buddle does very fair work if carefully attended to, but requires a large amount of labor, and does not save the *finest* sulphurets.

The raising gate may perhaps be best described as the sluice with riffles, improved by having the riffle raised gradually by machinery. The accompanying cut shows the raising gate *down, or open*; by the gear above it is gradually raised, the speed being changed at will by the step pulley.



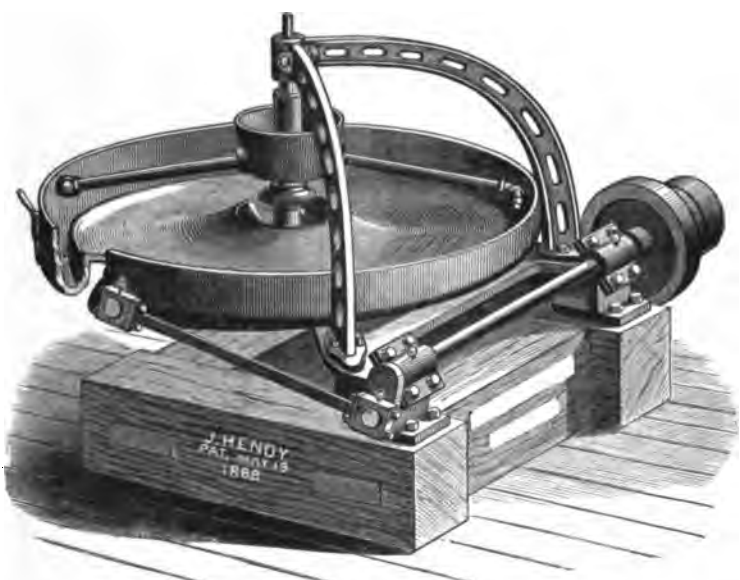
RAISING GATE
FOR
CONCENTRATING.

Scale, ⅜″ = 1 foot
Oct., 1898.

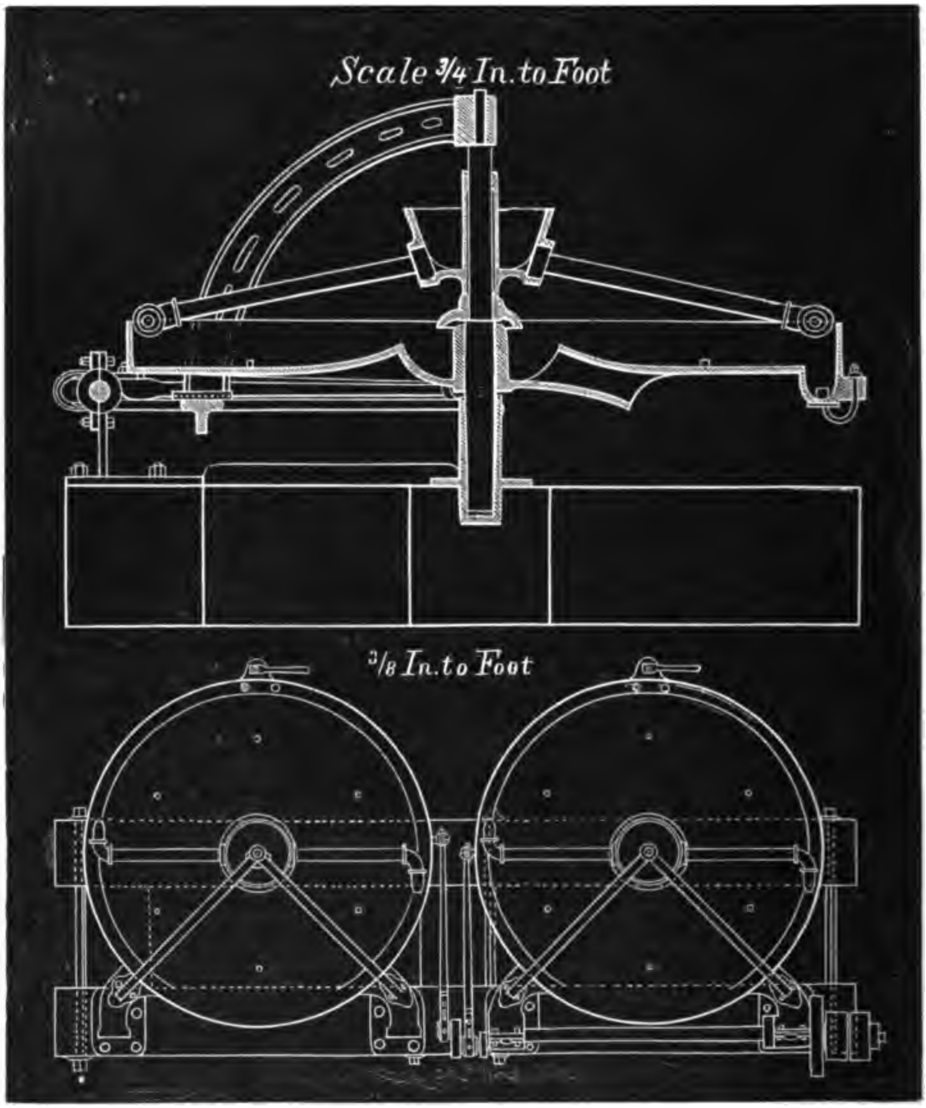
It saves some labor, but its work is about the same as the sluice with riffles, described above.

The Hendy concentrator was used very extensively for several years. The cut shows it to be circular, and of iron; the bottom is slightly convex, and at its periphery is a circular or annular trough, deeper than the main bottom. By the crank shaft it is given a short, quick, vibrating motion, horizontally, turning on its center as a pivot. The pulp is delivered into the bowl above the center, and is conveyed by two arms or pieces of pipe, and delivered on the concentrator at its periphery.

A depth of about 3 inches of material is kept in the concentrator; the heaviest settling to the bottom, and being moved gradually by centrifugal force towards the outside of the pan, where it collects in the annular trough, and discharges from a spout. The concentrations, still containing much sand, are passed through a third machine, and reasonably clean sulphurets obtained. The tailings pass off at the center of the machine, through the bottom.



HENDY CONCENTRATOR.



HENDY CONCENTRATOR.

At the Keystone Mill of forty stamps the pulp is passed through these concentrators, and their tailings pass over sluices with riffles.

In 1875, the writer, with his partner, commenced the arduous task of convincing the mining men of the coast that there was a heavy loss passing away from all the concentrating appliances in use, and that even a perfect concentrator needed proper conditions and proper care to secure its most efficient work. In most cases it was difficult to convince parties that their loss was really so great, and frequently we would be told that if a concentrator was good for anything, it should run itself and need no attention whatever.

The concentrator advocated by the writer as embodying the most correct principle in a good mechanical appliance (subsequently improved and perfected), was the Frue vanner, or ore concentrator; and after three years' constant work, and an expenditure of $30,000, success was attained, and the mining public were largely convinced of the importance of proper concentration of the gold and silver ores of the Pacific Coast.

The word "silver" is used because many of the sulphurets contain a large proportion of silver as well as gold. In the vicinity of Nevada City the production of sulphurets was more than doubled by using the vanners, and similar success attended their introduction and use elsewhere. Its success stimulated others to invent concentrators, so that many new concentrators have been brought before the public, many of them possessing merit, and almost all of them claiming superiority over the vanner.

Nevertheless, the sales of the vanner increase every year, and up to date amount to nearly $1,000,000.

The attention of the public is being drawn more and more every year to the importance and benefit of concentration, and even the low grade silver and gold ores of the Comstock Vein (Virginia City, Nevada), are being successfully and economically concentrated. These ores yielded no profit under the old method of amalgamation.

In former times the necessity of sizing even finely crushed ores was strongly insisted on to properly prepare the ore for concentration, but sizing is rarely found advisable with the concentrators now in use.

In some of the mining districts of this State the ore is very heavy with sulphurets, containing twenty per cent and over. Much of this can be separated by coarse crushing with rolls, etc., and jigging, and this method of treatment is advisable, as there is thus avoided a heavy loss of sulphurets in slime, which would occur if the original ore was finely crushed at first. The tailings from the jigs will still contain much sulphurets, locked up in the gangue, and should be finely crushed and passed over the vanner or some other concentrator.

Occasionally an ore is found in which the silver exists partly as chloride and partly as refractory sulphurets. Formerly such an ore was crushed dry, roasted, chloridized, and amalgamated, but even $30 ore would yield scarcely any profit, and the reduction works were very expensive.

For several years the writer contended that the proper method of treating such ore was by concentration first, and amalgamation without roasting of the tailings from the concentrators. In this manner the expensive dry crushing is replaced by wet crushing, which also doubles the capacity of the mill. The refractory part of the ore is saved by itself in such small compass that it can be either sold or shipped to smelters, or treated at the mill with small expense. The tailings from the concentrators do not need roasting, so that this great expense is saved, as well as the cost of the furnaces.

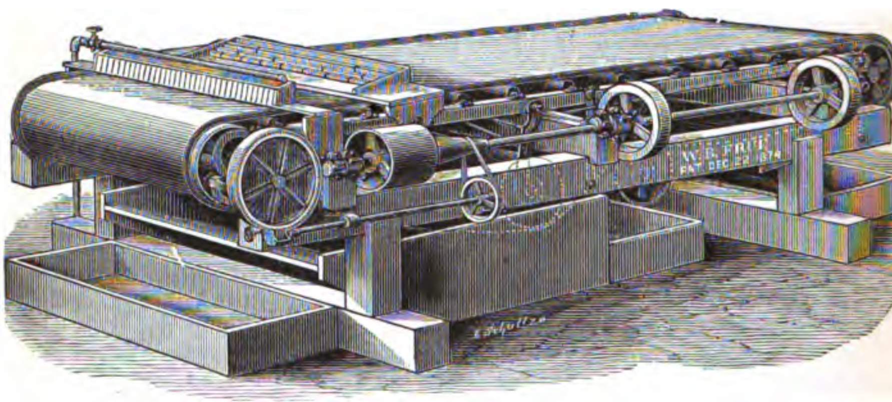
In some localities, ore worth only $6 a ton, can be made to pay by this method, while $30 ore would not pay by the old method of dry crushing, chloridizing, etc.

It is very important that the concentration is made before the amalgamation, for several reasons. The tailings from the concentrator contain no base mineral to trouble amalgamation or cause loss of quicksilver, and the Boss continuous process of pan amalgamation can be used with advantage and economy. If amalgamation should be used before concentration, the sulphurets are ground, and a large part is thereby made so fine that it cannot be saved on any concentrator; too much water, also, is with

the tailings, and there is an uneven discharge from the settlers and agitators.

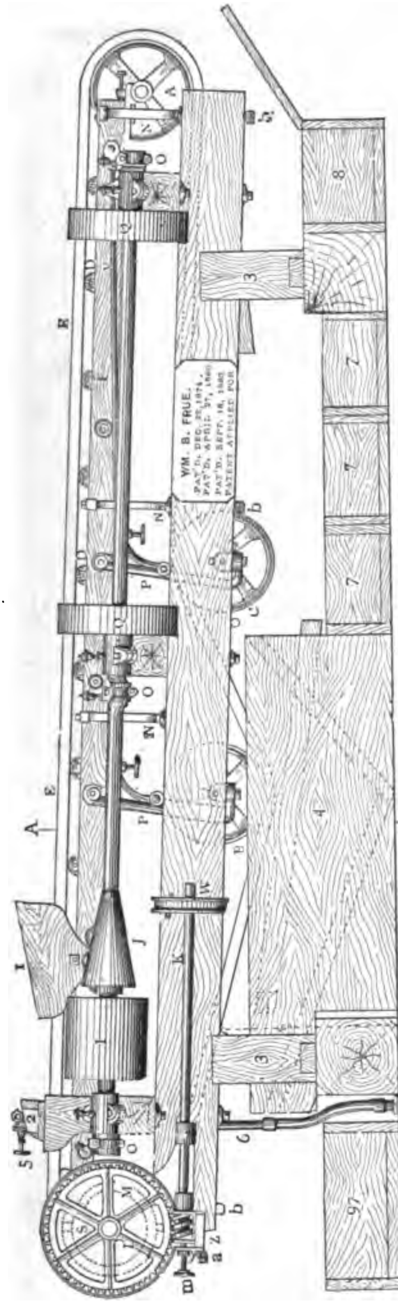
After advocating this method for several years, the writer at last succeeded in having it adopted five years ago by Mr. Randolph, acting for Mr. Alexander R. Shepherd, in the mines of Batopilas (Chihuahua, Mexico), and it is in successful operation there to-day. It is now used also at several mines in the United States.

The Frue vanner is familiar to thousands of mining men. The accompanying cut shows it in perspective, as manufactured several years ago.



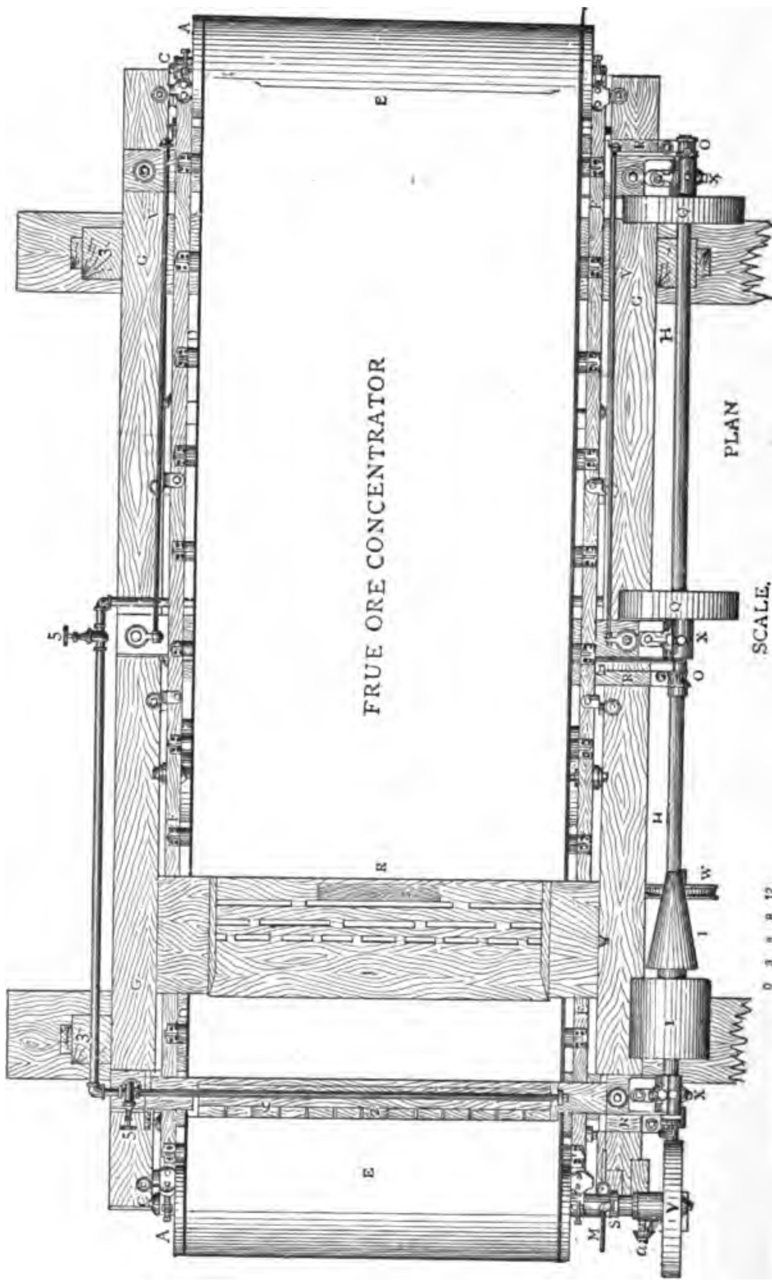
FRUE CONCENTRATOR.

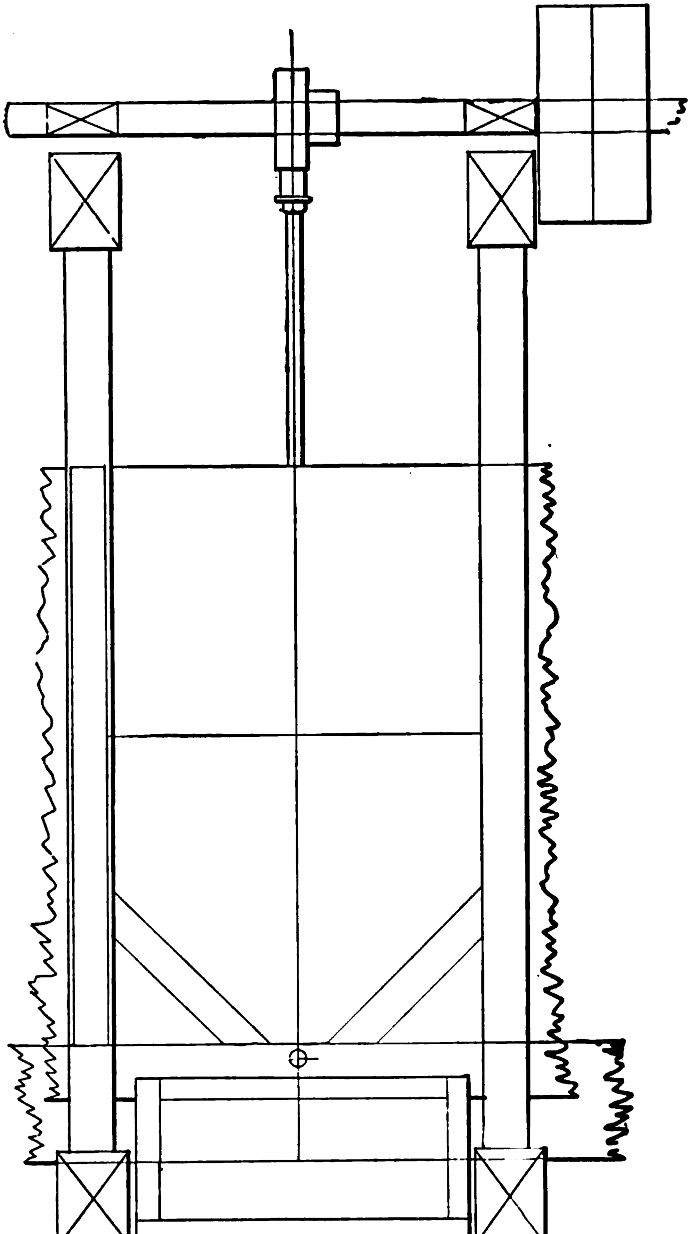
Since then many modifications and improvements have been made, but it is in the main as represented, and consists of an endless traveling rubber belt, with raised sides, moving slowly up hill, forming an inclined table (about $\frac{1}{4}$ inch to the foot being the grade, subject to change according to the ore), and having a short lateral motion of 1 inch, given by a crank shaft running from 180 to 200 revolutions a minute.



HORIZONTAL ELEVATION.

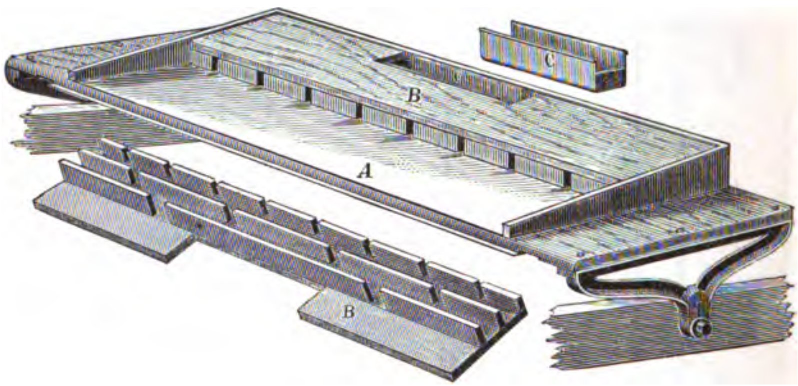
SCALE.


FRUE ORE CONCENTRATOR
PLAN
SCALE.



JIG Scale ¾"-1'

It can be further understood by the cut of the working drawing, which shows most of the improvements, except the present form of the ore spreader, which is as per cut below, and was devised, so that for gold ores, a silver-plated copper plate could be placed over the entire surface of the spreader, the top board *B*, with blocks attached being put on the plate; also the copper well *C*, in which is caught quicksilver which may escape from the main plate above; when the plate is to be cleaned, the top board and blocks are removed; this is only done occasionally.



FRUE ORE SPREADER.

The ore with water is delivered on the belt by means of the spreader No. 1, in working drawing, which shakes with the table, and distributes the pulp uniformly across the belt. A small amount of clean water is distributed by No. 2, which is a wooden trough in which is a perforated pipe. A depth of three-eighths to one-half inch of sand and water is constantly kept on the table. The main shaft, *H*, should be given the proper speed for each kind of ore, and once established, it should be kept uniform; this speed will be between 180 and 200 revolutions of the crank shaft per minute, with one inch throw.

The up-hill travel or progressive motion varies from 3 feet to 12 feet a minute, according to the ore, and the grade or inclination of the *table* is from 3 inches to 6 inches in 12 feet, varying with the ore. The inclination can be changed at will, by wedges at the foot of the machine. The motion, the water used, the grade, and the up-hill travel should be regulated for every ore individually, but once established no further trouble will be experienced in the manipulation.

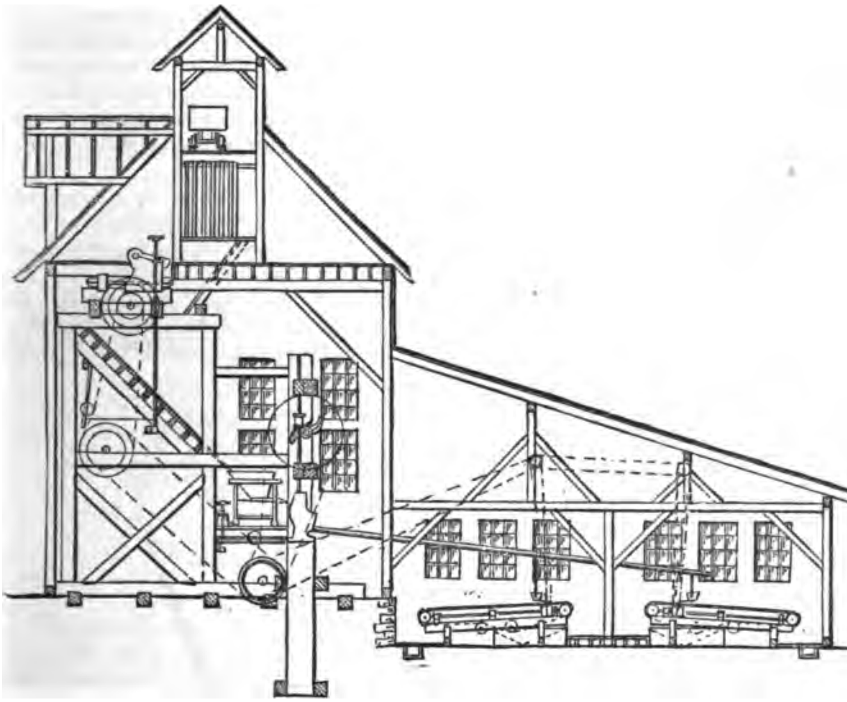
The main body of the belt suffers hardly any wear, as it merely moves its own weight slowly around the freely revolving rollers.

For one machine, ½ inch of water (miner's measure), or 6⅛ gallons a minute, including the water used in crushing, is as large an amount as is ever needed on any material, while on some ores 3 gallons will answer; and by returning the water from the settled tailings ½ gallon will keep up the loss.

The boiler for a 5-stamp mill with 2 concentrators consumes 1 gallon a minute, hence where water is very scarce 2 gallons a minute can supply 5 stamps, 2 Frue vanners, and the boiler.

As regards the capacity of the Frue vanner, about 6 tons per 24 hours passing a 40-mesh screen is as much as it is advisable to treat. If the battery of 5 stamps does its duty, the quantity crushed is largely in excess of 6 tons. For this reason, the best practice is to put 2 Frue vanners to 5

stamps, if the stamps are heavy and the sulphurets high grade and difficult to save; and in such event the pulp is divided, one half passing on each. The machines are generally placed in a double row, on the same level, head to head, as per cut of mill.



MILL SHOWING FRUE CONCENTRATOR IN PLACE.

In many cases 3 vanners to 10 stamps will yield entirely satisfactory work, and where the gangue is light, or the stamps not heavy, one vanner treats all the ore crushed with 5 stamps, and does perfect work; *e. g.*, in the Empire mill of 80 stamps, at Plymouth, in Amador County, 16 Frues are concentrating all the ore crushed by the 80 stamps, and the tailings assay merely a trace. No sizing of the ore is needed; the pulp passes directly from the stamps on the copper plates (if used), and thence on the vanners.

In running the machine the point of greatest importance is regularity; regularity in speed; regularity in the delivery of pulp on the belt, and regularity in the supply of clear water. The necessity of this is obvious to any one who thinks of the work to be done by an automatic machine.

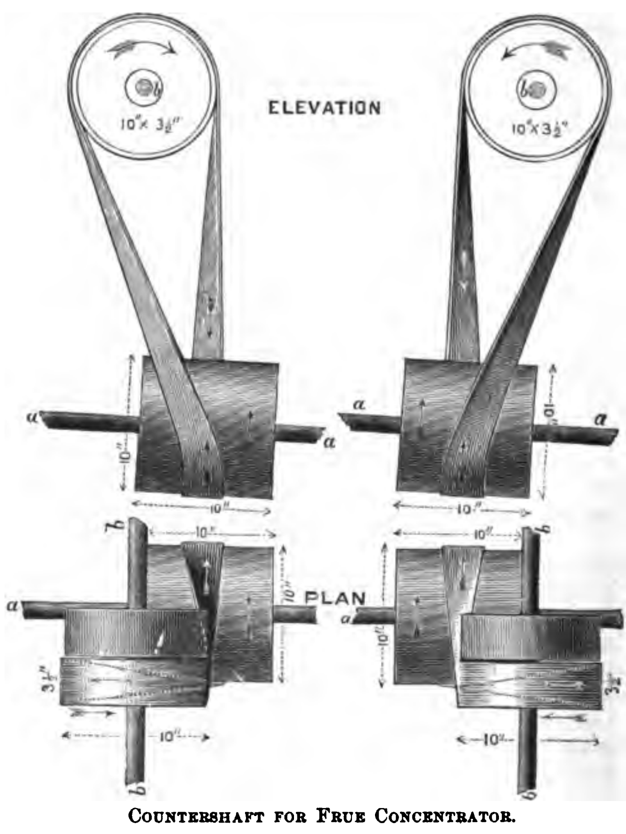
With hand labor the judgment of man regulates the means employed in conformity with varying conditions; but in a machine, the object of which is to supersede hand labor, it becomes obvious that having once adjusted the movements to effect a certain object under certain conditions, the desired result can only be attained by the maintenance of the necessary conditions.

In this concentrator, supposing the inclination of the belt to be fixed for a certain class of material, the regulation of the work to be accomplished is effected by three things, viz.: the speed with which the belt revolves, the

rapidity of the side shake, and the supply of clear water at the head. Having adjusted these three conditions to a given feed delivered on the belt, that feed should remain constant, and the result, both in the richness of mineral collected and in the poverty of the tailings, will be continuously maintained.

The countershaft to drive the Frue concentrators is placed parallel with the cam shaft and main line shaft of the mill, and is, therefore, at right angles to the crank shaft and pulley of the vanner. This necessitates the use of a quarter-twist belt, and the proper placing of this countershaft is very important, for with it properly set, the quarter-twist belt runs as well, as true, and with as little wear as if it were a straight belt; while if not properly set, it will run off the pulley.

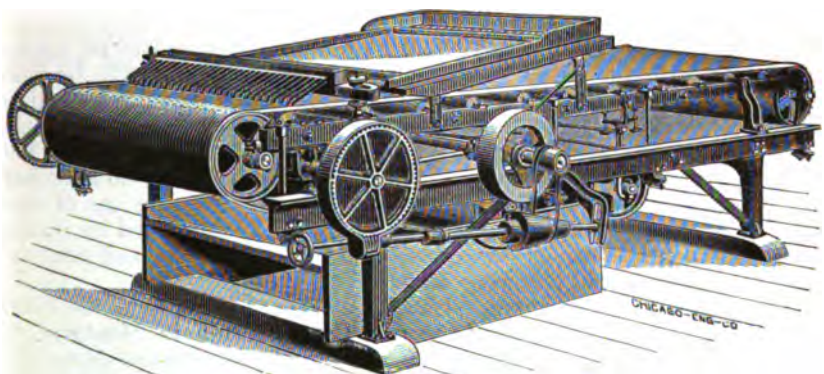
As this is not generally understood, even by good mechanics, the accompanying cut is given to illustrate the placing of this countershaft; *a a* is the crank shaft of the concentration; *b b* is the countershaft; on *b b* are one tight and one loose pulley; the belt is shown on the tight pulley. The crank shaft is not horizontal. The rule is as follows: "In placing the countershaft and its pulley, the pulley should be set so that the side from which the belt leaves it is in line with the square of the crank shaft of the concentrator at that point."



COUNTERSHAFT FOR FRUE CONCENTRATOR.

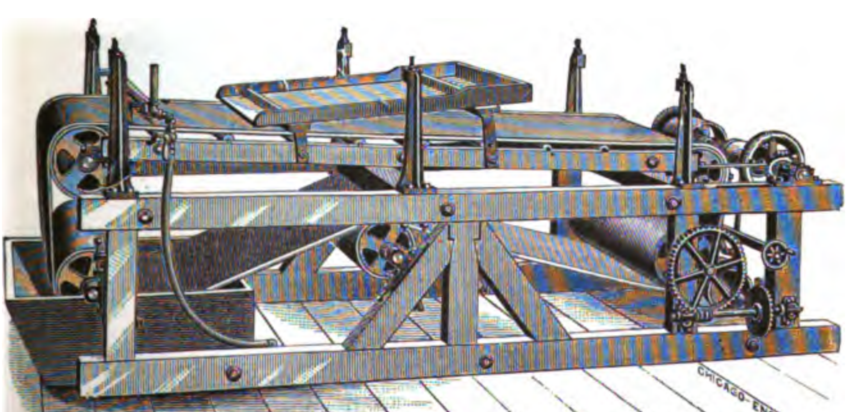
The Embrey concentrator is similar in most respects to the Frue vanner, differing chiefly in the direction of the shake, which is longitudinal. Not many of them have been put in use in California, as the Frue Company owns the Embrey patent, and believing the vanner to be the best machine, they have not pushed the Embrey.

Two forms of the Embrey machine are made, one compact in form, with crank shaft passing under the shaking frame, and supporting, by the latter, the whole weight of the belt and two underhanging rollers. This form is in fact identical with the vanner, except that the crank shaft is placed at right angles to the length of the belt, instead of parallel to same, and it is made with iron or wood frame, as preferred.



Embrey Concentrator, with Iron Frame.

The second form, and the one most desirable for economy in running, is arranged with the driving shaft at the lower end of shafting frame, so that while running all parts can be regulated, and any play taken up, and the shaking frame does not carry the hanging rollers, which are supported by the main frame, and carry about one half of the main belt. The shaking frame and mechanism is thus relieved of the weight of the two lower rollers, and nearly one half of the weight of the heavy belt, an important point, considering the high speed necessary on the end shake machine.



Embrey Concentrator, with Wooden Frame.

The only advantage of the first form over the second is in saving a little floor space for the same length of working belt.

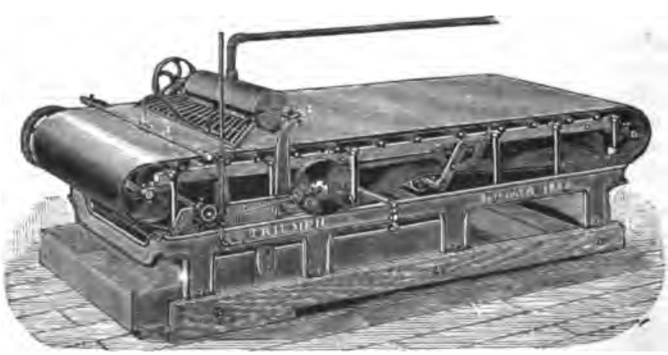
The advantages of the second form are in reduced power required, reduced wear and tear, and greater accessibility of working parts while in motion.

The accompanying cuts show the two forms of the Embrey, as they were made some time ago. Since they were engraved several improvements have been made, but time did not permit later cuts to be made. A few of the improvements consist in mechanism, for regulation of the progressive motion from in front of the machine; and the carrying or shaking frame is now supported from below, in the wooden frame machine, and not from above, as in the cut. Silvered copper plates on the ore distributor are used, when needed, to save amalgam.

If on the same belt both end and side shake mechanism be applied alternately, with the same conditions of feed and speed, it will be found that at a speed of 180 to 200 revolutions per minute, and the ordinary slight inclination of the belt, a perfect separation of clear mineral can be made on most ores with the vanner. If the end shake be substituted now, other conditions being the same, it will be found impossible to keep back the sand from passing over the mineral, even with excessive use of clean water at the head; and a separation can only be accomplished by increasing the speed to 235 or 240 revolutions, and increasing the speed naturally increases the wear and tear very materially.

The Embrey is in use in several mills in Colorado, Montana, the Southern States, etc., and at the Anaconda Copper Mine in Montana, the wooden-frame Embrey is preferred to any other concentrator. One of its patented points is the use of the vibrating water distributor.

The Triumph concentrator (see cut) is very much like the Embrey, which is the earlier machine.



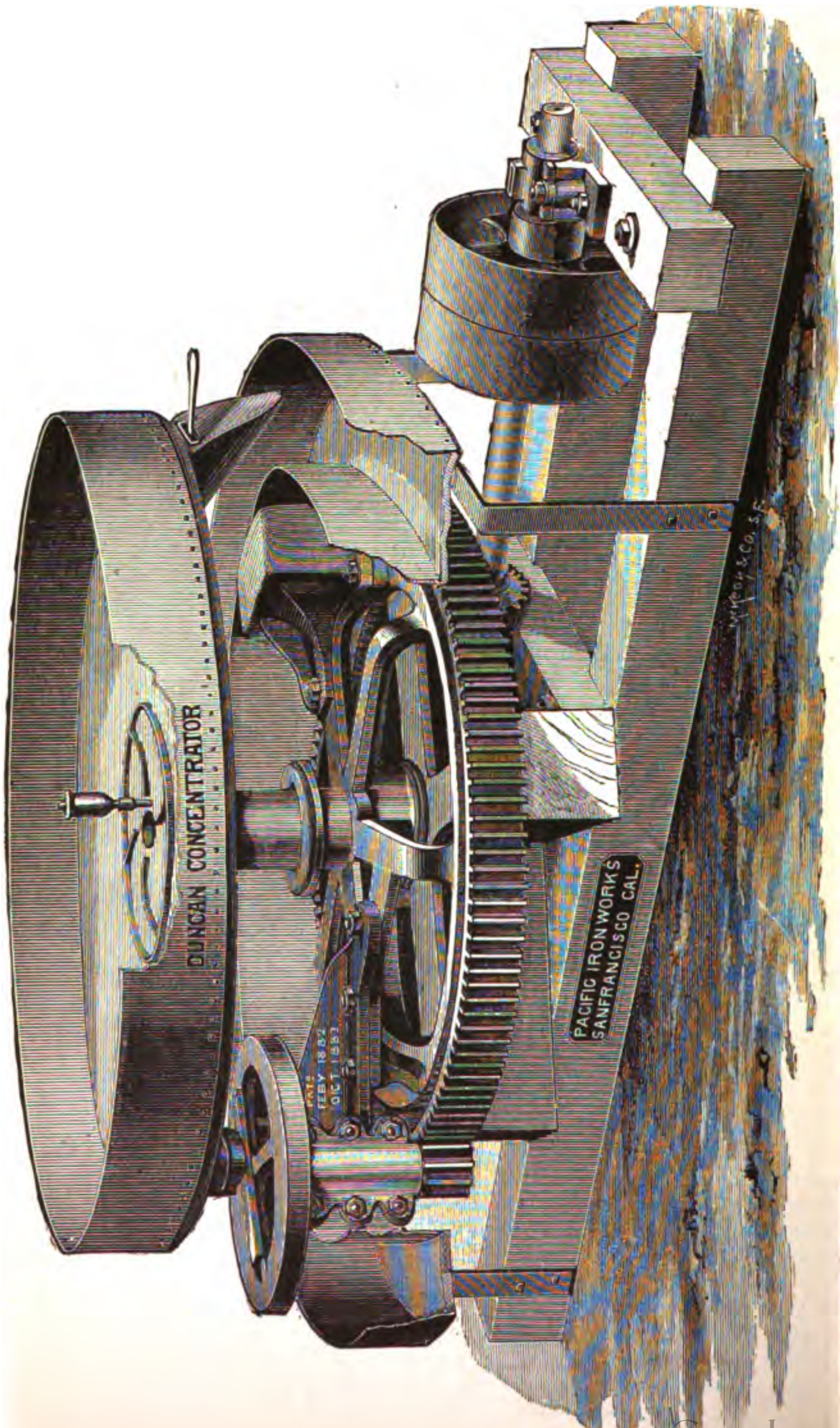
Triumph Concentrator.

It is a rubber belt, inclined, shaking longitudinally, and revolving slowly. Its crank shaft, like the Embrey, revolves from 235 to 240 times a minute, in order to make the separation of the mineral from the sand. Its main novelty is the use of a friction roller to regulate the forward motion of the belt, instead of a cone pulley, which is used in the vanner and Embrey machines. It has also an amalgam saver, consisting of an iron trough in which turns slowly a horizontal shaft, with stirrers. Quicksilver is kept in this trough. The shaking table is supported on upright springs, and the main frame is of cast-iron. It is a neat looking machine,

and can do good work. Many machines have been sold. It is in use at the Empire Mill (Grass Valley), and is liked.

The Duncan ore concentrator, like the Hendy concentrator, is circular in form, and of iron. Its principle is an ingenious combination of movements, imitating the process of panning by hand. "The agitation resulting from this movement causes the mineral to settle to the bottom around the outside of the pan, where it is held by centrifugal force, until discharged through the gates, while the gangue is held in suspension, and gradually carried by the force of the current to the central discharge. The pan, by this centrifugal motion, making, say eight and a half revolutions per minute, causes the pulp to flow around over its surface to the extent of about three revolutions, or equal to a distance of some thirty feet before it is discharged, thereby giving the sulphurets or other mineral time to settle before the gangue passes off.

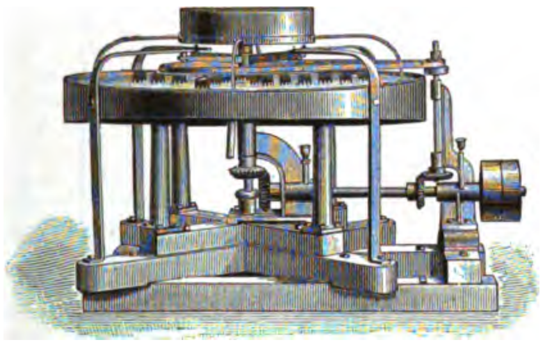
"The wrist-pin, on the balance-wheel, is made adjustable, so that the motion of the pan can be varied to adapt it to the requirements of different classes of ore."



DUNCAN CONCENTRATOR.

The foregoing is the description given by the manufacturers and owners of the Duncan concentrator. It is well made and many have been sold. Its weight is about 1,750 pounds, and it requires to run it about ½-horse power.

Shaw's disk concentrator and amalgamator is of recent introduction, and its merit therefor is not yet settled. It is described as follows by the inventor (please see cut also):



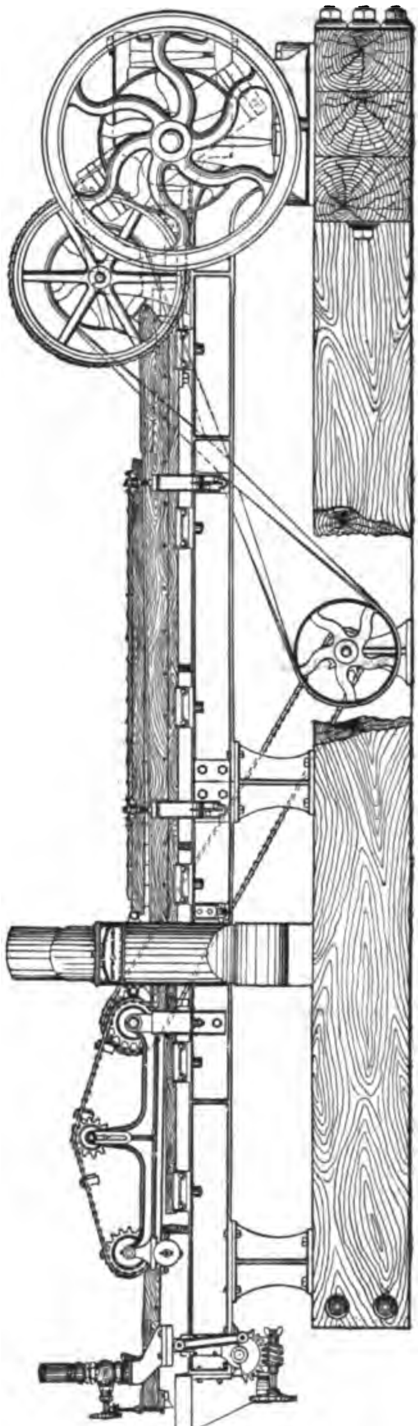
SHAW CONCENTRATOR.

In this machine there is a circular copper disk in the shape of a very shallow cone, with the apex turned downward, to which an eccentric motion of about one half inch throw is communicated by a vertical spindle, which is geared even to a light horizontal shaft, running from 250 to 300 revolutions per minute. The disk does not revolve, being subject only to the eccentric motion, the result being the panning motion, considered so desirable in all concentrating appliances. At work the pulp is received from the mill in the round pan with a perforated bottom supported over the center, passing in the form of rain onto the vibrating disk; the revolving stirrers keep the pulp active, thus allowing the heavier particles contained therein to percolate to the bottom. Coming in contact with the surface of the disk, they move at once towards the center, where a small screen is provided for their egress. The pulp composed of the worthless sands and water pass over the periphery of the disk and are carried off by means of the circular trough provided for that purpose.

In order to assist or retard the motion of the pulp towards the periphery, a number of revolving radial arms are provided, to which are secured at short intervals small notched stirrers of sheet copper, which dip into the pulp to within about a quarter of an inch of the face of the pan or disk. These revolving stirrers regulate the discharge of the pulp; they are set like wings and can be adjusted at different angles so as to throw the pulp out more or less rapidly as desired.

It can also be used as an amalgamator by replacing the screen in the center by a close fitting plug and quicksilvering the disk, but it is not intended to be used for its double purpose at the same time.

It is claimed to save the sulphurets clean with little loss, and to have capacity from 5 to 8 tons in 24 hours.



Golden Gate Concentrator.

GOLDEN GATE SULPHURET CONCENTRATOR.

[From a printed description issued by the company.]

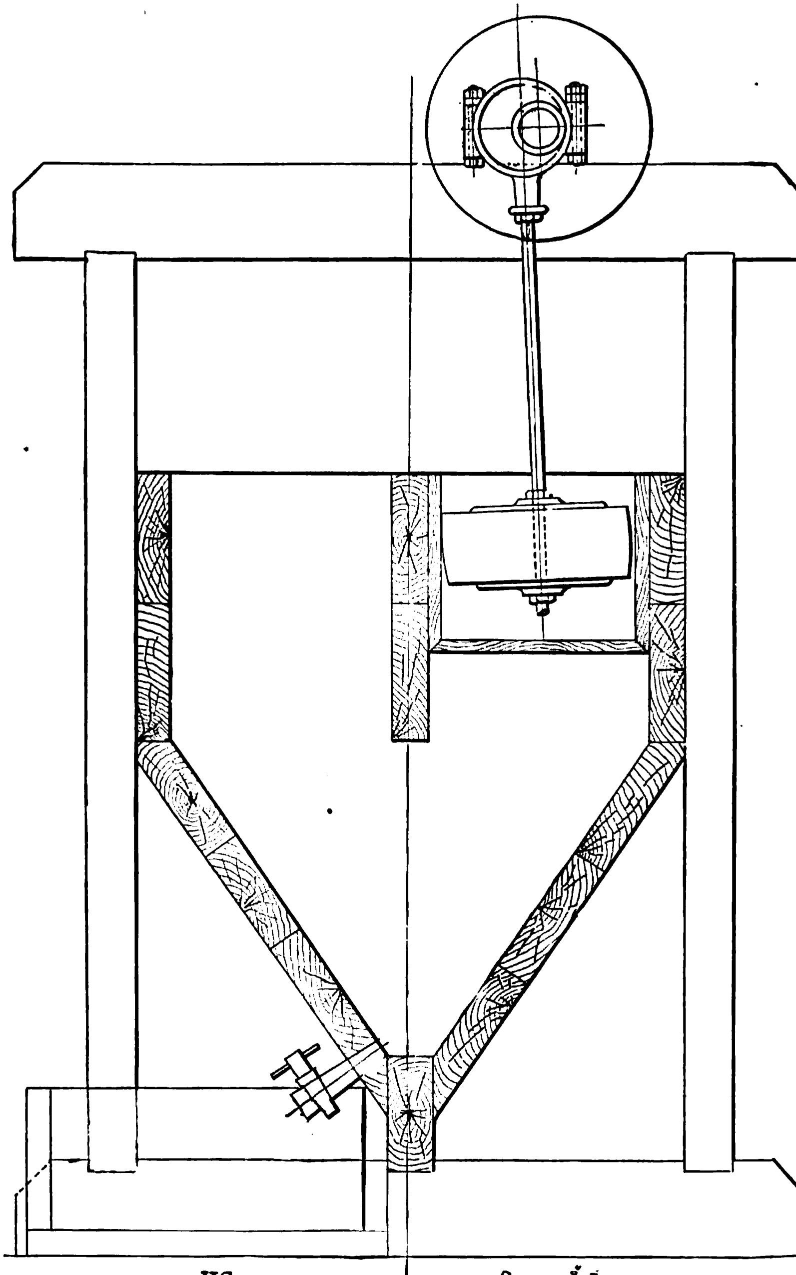
The Golden Gate sulphuret concentrator consists of a tray about eleven feet in length, resting upon a stout iron framework, upon which it has a longitudinally reciprocating movement. This reciprocating movement varies in speed in such manner as to cause the pulp, fed upon the tray at one end, to travel slowly over its surface towards the other end, and the pulp is, by the shaking motion, kept in a loose condition, so that the mineral may settle out of the gangue upon the surface of the tray. The tray proper consists of two distinct parts, forming, however, one continuous surface; one part, being designed for the settling of the mineral, is horizontal, and has hardly any perceptible current of water, thus allowing the fine mineral to settle out of the water and reach the bottom of the tray; the other part has an adjustable inclination upwards from its junction with the horizontal part, and over this part the current of wash water flows, which washes away the gangue from the mineral. At the junction of the horizontal with the inclined part of the tray, and extending across its width, is a "protecting plate," set somewhat above its surface, and parallel thereto. Above the protecting plate is an "exhaust pipe," within which a vacuum, sufficient to sustain a column of four or five inches of water, is constantly maintained by a small exhaust fan. On the lower side of the "exhaust pipe," above the "protecting plate," are openings into which the gangue and water are drawn, by the vacuum maintained, being then discharged over each side of the machine into the waste sluice.

The operation of the sulphuret concentrator is as follows:

The crushed ore, with a suitable amount of water, is fed onto the horizontal part of the tray, through the "distributor" shown at the extreme left of the figure. The peculiar motion communicated to the tray causes the pulp to slowly travel towards the "protecting plate," and at the same time keeps the pulp in a loose condition, allowing the heavier mineral to sink to the bottom, so that, on arriving at the plate, the pulp is separated into distinct layers, with the mineral at the bottom, the heavy gangue above the mineral, and the light gangue and water at the top; the plate having been properly adjusted for the ore, allows all the mineral, with some of the gangue, to pass under it, while the larger part of the gangue, and all the surplus water, pass *above* the plate, and on arriving at the exhaust pipe, are instantaneously drawn off and discharged over the sides of the tray into the waste sluice. That portion of the pulp which has passed under the plate, now consisting largely of mineral, continues on up the inclined part of the tray, where it can be freed from that part of the gangue which is still mixed with it, by a current of water flowing down from the head of the tray, this gangue and wash water being taken away by the exhaust pipe, as before explained.

The machine is very well made and of large capacity. It is in successful operation at the Brunswick Mill, Carson River, Nevada where six of them are handling the product of 56 stamps, crushing 160 tons of ore a day, and is also in use in other places.

There are possible problems in concentration in California requiring coarse crushing; this has already been discussed, and consequently the accompanying cut of one of the most approved styles of jigs should be of interest.



JIG SCALE $\frac{3}{8}''=1'$

Dry concentration is not discussed in this article, because it is little used in California, and in fact is rarely adopted if water can be obtained in sufficient quantity for wet concentration, because the latter gives uniformly better results with less cost, and less wear and tear.

In conclusion, I will state that these notes have been written hurriedly, as but little time was given me in which to prepare them. I have attempted, however, to be fair and just in my statements and criticisms.

CHLORINATION.

(By Wm. Irelan, Jr., State Mineralogist.)

This method of extracting gold from the auriferous sulphurets is recognized in the metallurgical circles of the old world as the Plattner process, and is so called in honor of the inventor. The honor of its introduction and successful adaptation to the working of our sulphuretted residues is due to the well known mining engineer and metallurgist Mr. G. F. Deetken, by whom it was first brought into this country.

Owing to the expense of manipulation, cost of material, and other obstacles, Mr. Deetken had much to contend with, but his well known skill and scientific ability enabled him to reach a successful issue and to become a metallurgical benefactor.

Since the demonstration of its successful workings on our concentrated sulphurets, a general knowledge of the manner of its application has been distributed by means of our scientific and other papers; also, books have been written by two of our well known metallurgists, in which the whole process is explicitly dealt with.

The first of the above mentioned works on the subject was issued by the late G. Kustel, in the year 1868, new edition 1880; and the latest exhaustive description is from the pen of Charles Howard Aaron, in 1881. Both authors were at the time of writing practically engaged in working the sulphurets of the State by this method.

The subject is inexhaustible, and of vital interest to the mining industry of our gold-bearing sections.

This article is not intended to give the detailed manipulations of the process, as the works above cited were written especially as working descriptions, and can be purchased of any of the booksellers.

THE ROAST.

This is the most important of any part of the process, and upon its completeness depends the success of the operation; therefore, too much care cannot be exercised in this branch of the operation.

In roasting, the point to be attained is the complete oxidation of the baser metals whose soluble salts would become precipitants for gold in the leaching vat. If the concentrated sulphurets have become lumpy, it will be necessary to recrush them, that the roast may secure complete oxidation.

It frequently happens that too much material is put into the furnace at one time: Mr. Aaron advises, for the reverbratory, from ten to twelve pounds for every square foot of hearth as the correct charge. The furnace should be fired up several hours before being charged with the dry sulphurets, and the heat should be of a degree just sufficient to ignite the sulphur after the material has been evenly spread over the hearth. Too great a heat will matte the easily fusible sulphides, thereby necessitating a withdrawal of the charge from the furnace and a repulverization. The presence of galena requires a low temperature and continual stirring. Mr. Deetkin discovered that the presence of lime and magnesia, owing to their

affinity for chlorine, were a detriment to the chlorination of the roasted ore, but he overcame this difficulty by an addition of salt to the charge in the furnace toward the completion of the roast. The roasting in all cases should be done at a gentle heat until the sulphur ceases to burn, which point is indicated by the disappearance of the characteristic blue flame, and the absence of scintillation on being raked. The heat is now increased and held at a high temperature until a thorough oxidation of the baser metals takes place. This can be ascertained by agitating, in a glass, a small quantity of the roast with water, allowing to settle, and adding to the clear decantation a few drops of the solution of ferrocyanide of potassium. If a dark blue precipitate is given, sulphate of iron is present; if brownish red, it indicates the presence of the corresponding copper salt; if both copper and iron are present, as soluble salts, the two colors will unite, forming a dirty greenish-blue mass; in either case the oxidation is incomplete, and the roasting must be continued until a further test does not give any of the described reactions.

Many operators continue the roasting to the oxidation of the iron only, but although it takes a longer time and a greater heat, it is advisable to also destroy the copper sulphate, as soluble metallic salts in the leaching vat react upon the iron oxide, which in turn precipitates the gold.

If the concentrated sulphurets contain silver, the Patera and Plattner processes should be combined. The silver is chloridized in the furnace by the addition of salt during the roasting. After the gold is washed from the ore, the silver chloride is leached out by a solution of hyposulphite of soda.

On the completion of the roast, the ore is drawn from the furnace to the cooling hearth, and, after a time, is sprinkled with water until moist enough to adhere when pressed in the hand.

THE LEACHING VAT.

In Europe the leaching is done in earthen or porcelain jars or tubs, wooden vats being condemned on account of their absorbing power. Mr. Deetkin overcame this difficulty by coating the vats on the inside with pitch and tar. The vat is circular, and has a perforated false wooden bottom, which is raised about an inch from the real bottom. This false bottom is covered, first, with a layer of coarse, barren quartz; then a layer of smaller pieces; and, lastly, a covering of clean quartz sand. Sometimes the sand is covered with gunnysacks or perforated boards. The damp roasted pulp is sifted into the vat and spread evenly and loosely until within about three inches of the top. The chlorine gas is now introduced through an opening in the bottom of the tank until it rises to the surface of the ore, which will be known by dense white fumes of chloride of ammonium being given off when a rod or stopper moistened with ammonia is held close to and above the charge. At this point the cover is put in place and carefully luted with some suitable tenacious substance that will not crack in drying. The chlorine is continued until the space above the ore is filled with the dense yellowish-green vapor; then the plug hole in the cover is stopped and the vat and contents are left at rest for from one to two days, at the expiration of which time the gold should be converted into a soluble chloride. Before leaching, the plug in the cover should be removed and the ammonia test applied. If there are no resulting white fumes, the ore must be again subjected to the chlorine, and so continued until the ammonia reaction is given.

The chlorine is generated in a leaden vessel from a mixture of common

salt, peroxide of manganese, sulphuric acid, and water. The reaction chemically given is: $2 (Na\,Cl) + 2 (H_2\,SO_4) + Mn\,O_2 = Na_2\,SO_4 + Mn\,SO_4 + (H_2O)_2 + 2\,Cl$.

Care must be taken in using the chlorine gas that no muriatic acid enters the leaching vat, for, beside attacking the oxides of the metals, should there be an imperfect roast the sulphides would be attacked, eliminating sulphuretted hydrogen gas, which would precipitate the gold from the chloride solution. The chlorine is deprived of the muriatic acid after leaving the generator on its course to the vat by passing the gas through water.

LIXIVIATION AND PRECIPITATION OF THE GOLD.

The ore being thoroughly chlorinated the cover is removed and water run into the vat until it rises above the surface of the mass. After a few minutes, when the water has had sufficient time to permeate all the ore, and still covers the surface, the plug at the bottom of the vat is removed and the liquor conducted to the settling tank into which has been put the precipitant for gold—a solution of sulphate of iron. A continuous flow of water must be admitted into the leaching vat, and at no time during the operation, which lasts several hours, should the water be permitted to fall below the surface of the ore. At intervals a glass full of the liquor, after having left the leaching vat, should be taken and thereto a little of the sulphate of iron solution added; if gold were present a bluish-black precipitate would be given. In the event of any precipitate resulting from the unity of the two solutions the washing is not finished but must be continued until the precipitant added to a freshly taken portion of the liquor does not give any reaction, or at the most only a faint coloration.

After a thorough stirring of the contents in the settling tank, the precipitate is allowed to subside, and a glass full of the clear liquid taken, to which is added a little of the sulphate of iron solution ; if a dark coloration is given, more sulphate of iron must be added to the liquor in the tank. Or, if on the addition of a few drops of gold solution to a little of the clear liquid from the tank no reaction is given, it is a confirmation of the former test that there is a deficiency of sulphate of iron.

Should the roasted ore contain chloride of silver, it is leached with a solution of hyposulphite of soda after extraction of the gold by water. The liquor is run into a tank set aside for this especial purpose, in which the silver is thrown down by a solution of calcium sulphide, as sulphide of silver. The outflow of the silver solution should be conducted slowly, by the closing at intervals of the discharge pipe, as the silver salt is not so readily extracted by its solvent as is the gold.

The presence of silver in the hyposulphite is known by the sweet taste of the liquid; but when it can be no longer detected in this wise, a little of the outflow is caught in a glass and a few drops of the calcium sulphide solution added ; if a dark precipitate is given, it is reasonable to suppose that the silver has not been entirely extracted, although other metallic salts, giving similar reactions, are also washed out by the same solvent. The only recourse at this point is to apply the confirming tests for such soluble compounds, as it is almost impossible to decide by the coloration which metals may be present. After the silver precipitate in the settling vat has subsided, a little of the calcium sulphide is added to the clear solution, and if a dark coloration is the result, it is evident that more of the precipitant must be added.

After the tests have shown a thorough precipitation of the gold and silver, the tanks are left undisturbed until the suspended precipitates have settled.

SILVER.

The silver precipitate will settle in a few hours, when the clear solution may be drawn off, the silver sulphide collected, conveyed to a filter, washed thoroughly with hot water, pressed, dried, and then roasted in a furnace—first, at a heat just sufficient to drive off the greater part of the sulphur; at this point the temperature should be increased to a dull red, and so continued for several hours, or until the greater part of the silver becomes metallic.

The partly metallized substance is placed with borax and iron scraps in a black lead crucible and fired until thoroughly melted; enough iron should be added that it does not all disappear in the operation. If an iron rod immersed in the molten mass, and allowed to remain a few minutes, shows no signs on removal of having reduced in size—the iron scraps should be removed, the matte and slag skimmed off, and the metal poured.

GOLD.

The contents in this tank should remain at rest for at least forty hours, for under that time a complete precipitation and settling of the gold can not be insured. When the gold has all settled at the bottom of the tank, the clear liquid is drawn off, the gold collected, filtered, washed several times with hot dilute hydrochloric acid, and lastly, with hot water, until all traces of acidity are removed. The gold is now dried, melted in a black lead crucible with borax, skimmed, base metals in a measure removed by the addition of niter, a little at a time, reskimmed, and poured.

The importance of saving sulphurets and working them by this process is shown in the annual statement of the Sierra Buttes Mine. From 1872 to 1885 the sulphurets were collected by the Hendy concentrator, and after exposure to atmospheric oxidation, were worked in the combination Stephenson-Patton pan. In 1885, the company erected chlorination works, at a cost of $5,000, by which they have added a yearly profit of $60,000 to the yield of the mine.

The ore of the Zeile Mine is crushed with special reference to saving the sulphurets; the crushings being sized to pass through a No. 4 slot screen, as finer particles would be more difficult of concentration.

MINERAL PRODUCTS OF THE UNITED STATES, 1885.

The following condensed statement of the mineral production of the United States in the calendar year 1885 is from advance proof sheets of a report shortly to be issued by the United States Geological Survey. This volume will be the third of the series known as "Mineral Resources" reports, prepared by the Division of Mining Statistics and Technology.

Coal.—The total commercial product of coal of all kinds in 1885, exclusive of that consumed at the mines, known as colliery consumption, was 95,834,705 long tons, valued at $152,915,108. Of this 32,265,421 long tons were Pennsylvania anthracite, valued at $72,274,544; while of other coals, including bituminous, brown coal, lignite, and small lots of anthracite produced outside of Pennsylvania, the production was 63,569,284 long tons, valued at $80,640,564 at the points of production. The total production, including colliery consumption, was: Pennsylvania anthracite, 34,228,548 long tons; all other coals, 64,840,668 long tons; making the total absolute production of the coal mines of the United States 99,069,216 long tons, valued as follows: Anthracite, $76,671,948; bituminous, $82,347,648; total, $159,019,596. The total production (including local consumption) of anthracite was 1,052,792 tons in excess of that of 1884, and its value was $10,320,436 greater. The total production of bituminous coal was 8,889,871 tons less than in 1884, but its value was $4,930,582 greater. The total production of coal of all kinds shows a net loss in tonnage of 7,837,079 long tons compared with that of 1884, but a gain in value of $15,251,018, the increase in value being due to an average increase of twenty-five cents per long ton. The total value is about the same as that of 1883.

Coke.—The total production of coke in 1885 was 5,106,696 short tons, valued at the ovens at $7,629,118. Of this Pennsylvania produced 78 per cent, or 3,991,805 tons, valued at $4,981,656. The remainder was produced by fourteen States and Territories. The maximum production of coke in the United States was reached in 1883, when 5,464,721 tons were made. This declined in 1884 to 4,873,805 tons. The production of 1885 shows a gain upon that of 1884, being within 360,000 tons of the make in 1883.

Petroleum.—The total production was 21,842,041 barrels of 42 gallons, of which the Pennsylvania and New York fields produced 20,776,041 barrels. The total value, at an average price of 87¾ cents per barrel, was $19,193,694. The production showed a decrease of 2,247,717 barrels and $1,282,600 in value from 1884.

Natural gas.—No record is kept of the yield in cubic feet. The amount of coal displaced by gas in 1885, was 3,161,600 tons, valued at $4,854,200. In 1884 the coal displaced was valued at $1,460,000. The yield has increased tenfold since 1883.

Iron.—The principal statistics for 1885 were: Domestic iron ore consumed, 7,600,000 long tons; value at mine $19,000,000. Imported iron ore consumed, 390,786 long tons; total iron ore conumed, 7,990,786 long tons; pig iron made, 4,044,526 long tons, a decrease of 53,343 tons as compared with 1884; value at furnace $64,712,400, or $9,049,224 less than in 1884. Total spot value of all iron and steel in the first stage of manufacture, excluding all duplications, $93,000,000, a decline of $14,000,000 from 1884.

Gold and silver.—The mint authorities estimate the value of the gold produced in 1885 at $31,801,000, an increase of $1,001,000 over 1884. The production of silver is similarly estimated at $51,600,000, an increase of $2,800,000 over 1884.

Copper.—The production in 1885, including 5,086,841 pounds made from imported pyrites, was 170,962,607 pounds, valued in New York at $18,292,999, at the average price of 10.7 cents per pound. The increase in pounds over 1884 was 25,740,667; in value $503,312.

Lead.—Production, 129,412 short tons. Total value, at an average price of $81 per short ton at the Atlantic coast, $10,469,431, a decline of 10,485 tons and $67,611 in value from the product of 1884. The production of white lead is estimated at 60,000 short tons, worth, at 5¼ cents per pound, $6,300,000.

Zinc.—The production of metallic zinc in 1885 was 40,688 short tons, valued at $3,539,856 at an average value of 4.35 cents per pound, an increase of 2,144 tons and $117,149 in value over 1884. Zinc was also made from the ore directly into zinc white (zinc oxide) to the extent of 15,000 short tons, valued at $1,050,000.

Quicksilver.—Production, 32,073 flasks (of 76½ pounds net), or 160 flasks more than in 1884. Total value, at an average price of $30 53 per flask at San Francisco, $979,189, an increase of $42,861 over 1884. The production of quicksilver vermilion was about 600,000 pounds, the same as in 1884, but the price advanced to 52 cents per pound, making the total value $312,000.

Nickel.—The production of metallic or "grain" nickel was 245,504 pounds, valued at $169,397. In addition, matte and ore containing 32,400 pounds of nickel were exported. Total value of all nickel, $190,000.

Cobalt.—The amount of cobalt oxide was 8,423 pounds, valued at $19,373. The total value of cobalt in ore, matte, and the above oxide was $65,373.

Manganese.—The production of manganese ore was 23,258 long tons, valued at $190,281. Manganiferous iron ore, 3,237 long tons, valued at $17,318. Total value, $207,599.

Chromium.—The production of chrome iron ore was 2,700 long tons, valued at $40,000. The consumption for making potassium and sodium bichromates increased markedly, due to imports of chrome iron ore from Asia Minor.

Tin.—Probably 200 tons of "black tin" ore were made at the concentrating works at the Etta Mine in Dakota. No smelting works have yet been erected.

Platinum.—The amount of crude platinum mined in 1885 was about 250 troy ounces, valued at $187 50 (?). This is exclusive of about 300 ounces of iridosmine, for pointing pens.

Aluminum.—The production of metallic aluminum increased from 1,800 troy ounces in 1884 to 3,400 ounces in 1885, valued at $2,550. Aluminum bronze, containing 10 per cent aluminum, was made to the amount of about 4,500 pounds, valued at $1,800.

Building stone.—Value, $19,000,000; about the same as in 1884.

Brick and tile.—The demand and consequent production increased to an estimated value of $35,000,000 in 1885.

Lime.—With the price constant at 50 cents per barrel at the kilns, the production increased from 37,000,000 barrels in 1884 to 40,000,000 in 1885.

Cement.—The production of cement from natural rock increased to 4,000,000 barrels of 300 pounds each, but was valued at only $3,200,000. Artificial Portland cement amounted to 150,000 barrels of 400 pounds each,

with a total value of $292,500. The total production of cement of all kinds was 4,150,000 barrels, valued at $3,492,500, against $3,720,000 in 1884.

Precious stones.—The value of American precious stones produced in 1885, was $69,900. This includes $42,800 for stones sold as specimens and souvenirs, and $27,100 for stones to be cut into gems. Besides this, gold quartz, with an estimated value of $140,000, was sold for specimens, and for ornaments and jewelry.

Millstones.—The trade in millstones of all kinds has decreased markedly from the introduction of roller mills. The total value of the Esopus millstones in New York, and Cocalico stone in Pennsylvania, did not exceed $100,000 in 1885.

Grindstones.—Estimated value of product for 1885, $500,000.

Phosphates.—With the exception of a local consumption of about 1,000 tons in North Carolina, the total production of phosphate rock came from South Carolina, and amounted to $437,856 long tons of washed rock for the calendar year 1885, valued at $2,846,064, at an average value of $6 50 per ton.

Gypsum.—The estimated production of land plaster in 1885, was 100,600 short tons; of calcined plaster, 72,000 tons; total, 172,800; valued at $959,-600. The above includes 75,100 tons from native stone, the remainder being imported from Nova Scotia.

Salt.—The total production in barrels of 280 pounds, was 7,038,653; exceeding the yield of 1884 by 523,716 barrels. The total value of all salt produced was $4,930,621, an increase of $732,887, which was due partly to the increased value of the Michigan product, and partly to the large increase in the production of western New York.

Bromine.—The production increased slightly, being about 310,000 pounds, against 281,100 in 1884. The total value, at an average of 29 cents per pound, was $89,900, an increase of $22,436 above the previous year.

Borax.—Production, limited to California and Nevada, 8,000,000 pounds; value, at 6 cents per pound for concentrated, $480,000. While the product increased by 1,000,000, the fall in price lowered the total value by $10,000.

Sulphur.—Tho production was only about 700 tons, worth about $18,000.

Pyrites.—About 49,000 long tons were mined, valued at $220,500. In addition 47,500 tons were imported.

Barytes.—The production was about 15,000 tons, valued at $75,000, in the unground condition, as taken from the mines.

Mica.—The production decreased in the West, owing to the inferior value of the sheets obtained. The whole product, excluding waste, was 92,000 pounds, valued at $161,000.

Feldspar.—Production, 13,600 long tons, valued, before grinding, at $68,000.

Asbestus.—The amount mined was about 300 short tons, valued at $9,000.

Asphaltum.—The production remained constant at about 3,000 tons, with a spot value of $10,000.

Mineral Waters.—The sales amounted to $1,312,845, from 9,148,401 gallons; the value is slightly less than in 1884. The great decrease in the number of gallons is due to the exclusion of the water from artesian wells in Madison, Wisconsin, which is used as the regular city supply. A large local consumption is also excluded.

Totals.—The statements made in the last report in regard to the total mineral product require little change for the year 1885. The statistics have been compiled with a view to giving information on those points which are of most interest and utility, and are presented in the form usual in the several branches of trade statistics. Comparing the totals given since 1882, a continuous decrease in value is noted in 1883 and 1884, being marked in the latter year. The year 1885 shows, on the other hand, an increase, due, no doubt, in part to more complete returns and closer estimates, but indicating, nevertheless, a more profitable business year, which would be still more apparent if the last half were compared with the corresponding period in 1884, since in many important branches of trade, prices increased towards the end of the year.

METALLIC PRODUCTS OF THE UNITED STATES IN 1885.

	Quantity.	Value.
Pig iron, spot value—long tons	4,044,525	$64,712,400
Silver, coining value—troy ounces	39,910,279	51,600,000
Gold, coining value—troy ounces	1,538,376	31,801,000
Copper, value at New York City—pounds*	170,962,607	18,292,999
Lead, value at New York City—short tons	129,412	10,469,431
Zinc, value at New York City—short tons	40,688	3,539,856
Quicksilver, value at San Francisco—flasks	32,073	979,189
Nickel, value at Philadelphia—pounds	277,904	191,753
Aluminum, value at Philadelphia—troy ounces	3,400	2,550
Platinum, value, crude, at New York City—troy ounces	250	187
Total	....	$181,589,365

* Including copper from imported pyrites.

NON-METALLIC MINERAL PRODUCTS OF THE UNITED STATES IN 1885 (SPOT VALUES).

	Quantity.	Value.
Bituminous coal, brown coal, lignite, and anthracite, mined elsewhere than in Pennsylvania—long tons*	64,840,668	$82,347,648
Pennsylvania anthracite—long tons†	34,228,548	76,671,948
Petroleum—barrels	21,842,041	19,193,694
Building stone		19,000,000
Lime—barrels	40,000,000	20,000,000
Salt—barrels	7,038,653	4,825,345
Cement—barrels	4,150,000	3,492,500
South Carolina phosphate rock—long tons	437,856	2,846,064
Limestone for iron flux		1,694,656
Mineral waters—gallons sold	9,148,401	1,312,845
Natural gas		4,854,200
Zinc, white—short tons	15,000	1,050,000
Concentrated borax—pounds	8,000,000	480,000
New Jersey marls—short tons	875,000	437,500
Mica	92,000	161,000
Pyrites	49,000	220,500
Gold quartz souvenirs, jewelry, etc.		140,000
Manganese ore—long tons	23,258	190,281
Crude barytes—long tons	15,000	75,000
Ocher—long tons	3,950	43,575
Precious stones		69,900
Bromine—pounds	310,000	89,900
Feldspar—long tons	13,600	68,000
Chrome iron ore—long tons	2,700	40,000
Asbestus—short tons	300	9,000
Slate ground as a pigment—long tons	1,975	24,687
Sulphur—short tons	715	17,875
Asphaltum—short tons	3,000	10,500
Cobalt oxide—pounds	68,723	65,373
Total		$239,431,991

* The commercial product, that is, the amount marketed, was only 63,569,284 tons, valued at $80,640,564.
† The commercial product, that is, the amount marketed, was only 32,265,421 tons, valued at $72,274,544.

RÉSUMÉ OF THE VALUES OF THE METALLIC AND NON-METALLIC MINERAL SUBSTANCES PRODUCED IN THE UNITED STATES IN 1885.

Metals	$181,589,365
Mineral substances named in the foregoing table	239,431,991
Total	$421,021,356
Estimated value of mineral products unspecified	7,500,000
Grand total	$428,521,356

SUMMARY OF THE MINERAL PRODUCTS OF THE UNITED STATES, CALENDAR YEARS 1882, 1883, 1884, AND 1885.

Product.	1882. Quantity.	1882. Value.	1883. Quantity.	1883. Value.
Metallic.				
Pig iron, spot value—long tons	4,623,323	$106,336,429	4,595,510	$91,910,200
Silver, coining value—troy ounces	36,197,695	46,800,000	35,733,622	46,200,000
Gold, coining value—troy ounces	1,572,186	32,500,000	1,451,249	30,000,000
Copper, value at New York City—pounds	91,646,232	16,038,091	117,151,795	18,064,807
Lead, value at New York City—short tons	132,890	12,624,550	143,957	12,322,719
Zinc, value at New York City—short tons	33,765	3,646,620	36,872	3,311,106
Quicksilver, value at San Francisco—flasks	52,732	1,487,042	46,725	1,253,632
Nickel, value in Philadelphia—pounds	281,616	309,777	58,800	52,920
Antimony, value at San Franccisco—short tons	60	12,000	----------	----------
Platinum, value (crude) at New York City—troy ounces	200	600	200	600
Aluminum, value at Philadelphia—troy ounces	----------	----------	1,000	875
Total value metallic products	----------	$219,755,109	----------	$203,116,859
Non-Metallic (Spot Values).				
Bituminous coal—long tons	60,861,190	$76,076,487	68,531,500	$82,237,800
Pennsylvania anthracite—long tons	31,358,264	70,556,094	34,336,469	77,257,055
Petroleum—barrels	30,053,500	23,704,698	23,400,229	25,740,252
Lime—barrels	31,000,000	21,700,000	32,000,000	19,200,000
Building stone	----------	21,000,000	----------	20,000,000
Salt—barrels	6,412,373	4,340,140	6,192,231	4,211,042
Cement—barrels	3,250,000	3,672,750	4,190,000	4,293,500
Limestone for iron flux—long tons	3,850,000	2,310,000	3,814,273	1,907,136
South Carolina phosphate rock—long tons	332,077	1,992,462	378,380	2,270,280
New Jersey marl—short tons	1,080,000	540,000	972,000	486,000
Borax—pounds	4,236,291	338,903	6,500,000	585,000
Mica—pounds	100,000	250,000	114,000	285,000
Ocher—long tons	7,000	105,000	7,000	84,000
Soapstone—short tons	6,000	90,000	----------	----------
Crude barytes—long tons	20,000	80,000	27,000	108,000
Precious stones	----------	75,000	----------	74,050
Gold-quartz souvenirs, jewelry, etc.	----------	75,000	----------	115,000
Pyrites—long tons	12,000	72,000	25,000	137,500
Manganese ore—long tons	3,500	52,500	8,000	120,000
Chrome iron ore—long tons	2,500	50,000	3,000	60,000
Asbestus—short tons	1,200	36,000	1,000	30,000
Graphite—pounds	425,000	34,000	575,000	46,000
Cobalt oxide—pounds	11,653	32,046	1,096	2,795
Slate ground as pigment—long tons	2,000	24,000	2,000	24,000
Sulphur—short tons	600	21,000	1,000	27,000
Asphaltum—short tons	3,000	10,500	3,000	10,500
Corundum—short tons	500	6,250	----------	----------
Pumice-stone—short tons	70	1,750	----------	----------
Feldspar—long tons	----------	----------	14,100	71,112
Zinc-white—short tons	----------	----------	----------	----------
Bromine—pounds	----------	----------	301,100	72,264
Mineral waters—gallons sold	----------	----------	7,529,423	1,119,603
Natural gas	----------	215,000	----------	475,000
Total value non-metallic mineral products	----------	$227,461,580	----------	$241,049,889
Total value metallic products	----------	219,755,109	----------	203,116,859
Estimated value of mineral products unspecified	----------	8,000,000	----------	8,000,000
Grand total	----------	$455,216,689	----------	$452,166,748

SUMMARY OF THE MINERAL PRODUCTS OF THE UNITED STATES, ETC.—Continued.

Products.	1884.		1885.	
	Quantity.	Value.	Quantity.	Value.
Metallic.				
Pig-iron, spot value—long tons	4,097,868	$73,761,624	4,044,525	$64,712,400
Silver, coining value—troy ounces	37,744,605	48,800,000	39,910,279	51,600,000
Gold, coining value—troy ounces	1,489,949	30,800,000	1,538,376	31,801,000
Copper, value at New York City—pounds	147,805,407	18,106,162	170,962,607	18,292,999
Lead, value at New York City—short tons	139,897	10,537,042	129,412	10,469,431
Zinc, value at New York City—short tons	38,544	3,422,707	40,688	3,539,856
Quicksilver, value at San Francisco—flasks	31,913	936,327	32,073	979,189
Nickel, value at Philadelphia—pounds	64,550	48,412	277,904	191,753
Antimony, value at San Francisco—short tons				
Platinum, value (crude) at New York City—troy ounces	150	450	250	187
Aluminum, value at Philadelphia—troy ounces	1,800	1,350	3,400	2,550
Total value metallic products		$186,414,074		$181,589,365
Non-Metallic (spot values).				
Bituminous coal—long tons	73,730,539	$77,417,066	64,840,668	$82,347,648
Pennsylvania anthracite—long tons	33,175,756	66,351,512	34,228,548	76,671,948
Petroleum—barrels	24,089,758	20,476,294	21,842,041	19,193,694
Lime—barrels	37,000,000	18,500,000	40,000,000	20,000,000
Building stone		19,000,000		19,000,000
Salt—barrels	6,514,937	4,197,734	7,038,653	4,825,345
Cement—barrels	4,000,000	3,720,000	4,150,000	3,492,500
Limestone for iron flux—long tons	3,401,930	1,700,965		1,694,656
South Carolina phosphate rock—long tons	431,779	2,374,784	437,856	2,846,064
New Jersey marls—short tons	875,000	437,500	875,000	437,500
Borax—pounds	7,000,000	490,000	8,000,000	480,000
Mica—pounds	147,410	368,525	92,000	161,000
Ocher—long tons	7,000	84,000	3,950	43,575
Soapstone				
Crude barytes—long tons	25,000	100,000	15,000	75,000
Precious stones		82,975		69,900
Gold quartz souvenirs, jewelry, etc.		140,000		140,000
Pyrites—long tons	35,000	175,000	49,000	220,500
Manganese ore—long tons	10,000	120,000	23,258	190,281
Chrome iron ore—long tons	2,000	35,000	2,700	40,000
Asbestus—short tons	1,000	30,000	300	9,000
Graphite				
Cobalt oxide—pounds	2,000	5,100	68,723	65,373
Slate ground as a pigment—long tons	2,000	20,000	1,975	24,687
Sulphur—short tons	500	12,000	715	17,875
Asphaltum—short tons	3,000	10,500	3,000	10,500
Corundum				
Pumice stone				
Feldspar—long tons	10,900	55,112	13,600	68,000
Zinc-white—short tons	13,000	910,000	15,000	1,050,000
Bromine—pounds	281,100	67,464	310,000	89,900
Mineral waters—gallons sold	10,215,328	1,459,143	9,148,401	1,312,845
Natural gas		1,460,000		4,854,200
Total value non-metallic mineral products		$219,800,674		$239,431,991
Total value metallic products		186,414,074		181,589,365
Estimated value of mineral products unspecified		7,000,000		7,500,000
Grand total		$413,214,748		$428,521,356

DEPARTMENT OF THE INTERIOR. UNITED STATES GEOLOGICAL SURVEY, J. W. POWELL, DIRECTOR.

MINERAL PRODUCTS OF THE UNITED STATES, CALENDAR YEARS 1882, 1883, 1884, AND 1885.

PRODUCTS.	1882.		1883.		1884.		1885.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Metallic.								
Pig iron, spot value (*a*)—long tons (*b*)	4,623,323	$106,336,429	4,595,510	$91,910,200	4,097,868	$73,761,624	4,044,525	$64,712,400
Silver, coining value (*c*)—troy ounces	36,197,695	46,800,000	35,733,622	46,200,000	37,744,605	48,800,000	39,910,279	51,600,000
Gold, coining value (*d*)—troy ounces	1,572,186	32,500,000	1,451,249	30,000,000	1,489,949	30,800,000	1,538,376	31,801,000
Copper (*e*) value at N. Y. City—pounds	91,646,232	16,038,091	117,151,795	18,064,807	147,805,407	18,106,162	170,962,607	18,292,999
Lead, value at N. Y. City—short tons	132,890	12,624,550	143,957	12,322,719	139,897	10,537,042	129,412	10,469,431
Zinc, value at N. Y. City—short tons	33,765	3,646,620	36,872	3,311,106	38,544	3,422,707	40,688	3,539,856
Quicksilver, value at San Fran.—flasks (*f*)	52,732	1,487,042	46,725	1,253,632	31,913	936,327	32,073	979,189
Nickel (*g*), value at Philadelphia—lbs.	281,616	309,777	58,800	52,920	64,550	48,412	277,904	191,753
Antimony, value at San Francisco—short tons	60	12,000	(*h*)		(*h*)			
Platinum, value (crude) at New York City—troy ounces	200	600	200	600	150	450	250	187
Aluminum, value at Phila.—troy ounces			1,000	875	1,800	1,350	3,400	2,550
Total value metallic products		$219,755,109		$203,116,859		$186,414,074		$181,589,365
Non-Metallic (spot values).								
Bituminous coal (*i*)—long tons	(*j*) 60,861,190	$76,076,487	(*k*) 68,531,500	$82,237,800	(*l*) 73,730,539	$77,417,066	(*m*) 64,840,668	$82,347,648
Pennsylvania anthracite—long tons	(*n*) 31,358,264	70,556,094	(*o*) 34,336,469	77,257,055	(*p*) 33,175,756	66,351,512	(*q*) 34,228,548	76,671,948
Petroleum—barrels (*r*)	(*s*) 30,053,500	23,704,698	23,400,229	25,740,252	24,089,758	20,476,294	21,842,041	19,193,694
Lime—barrels (*t*)	31,000,000	21,700,000	32,000,000	19,200,000	37,000,000	18,500,000	40,000,000	20,000,000
Building stone		21,000,000		20,000,000		19,000,000		19,000,000
Salt—barrels (*u*)	6,412,373	4,340,140	6,192,231	4,211,042	6,514,937	4,197,734	7,038,653	4,825,345
Cement—barrels (*v*)	3,250,000	3,672,750	4,190,000	4,293,500	4,000,000	3,720,000	4,150,000	3,492,500
Limestone for iron flux—long tons	3,850,000	2,310,000	3,814,273	1,907,136	3,401,930	1,700,965		1,694,656
S. Carolina phosphate rock (*w*)—long tons	332,077	1,992,462	378,380	2,270,280	431,779	2,374,784	(*x*) 437,856	2,846,064
New Jersey marls—short tons	1,080,000	540,000	972,000	486,000	875,000	437,500	875,000	437,500
Borax—pounds	4,236,291	338,903	6,500,000	585,000	7,000,000	490,000	8,000,000	480,000
Mica—pounds	100,000	250,000	114,000	285,000	147,410	368,525	92,000	161,000
Ocher—long tons	7,000	105,000	7,000	84,000	7,000	84,000	3,950	43,575
Soapstone—short tons	6,000	90,000	(*h*)		(*h*)			
Crude barytes—long tons	20,000	80,000	27,000	108,000	25,000	100,000	15,000	75,000
Precious stones		75,000		74,050		82,975		69,000
Gold-quartz souvenirs, jewelry, etc.		75,000		115,000		140,000		140,000

Pyrites—long tons	12,000	72,000	25,000	137,500	35,000	175,000	49,000	220,500
Manganese ore—long tons	3,500	52,500	8,000	120,000	10,000	120,000	23,258	190,281
Chrome iron ore—long tons	2,500	50,000	3,000	60,000	2,000	35,000	2,700	40,000
Asbestus—short tons	1,200	36,000	1,000	30,000	1,000	30,000	300	9,000
Graphite—pounds	425,000	34,000	575,000	46,000	....	....	....	....
Cobalt oxide—pounds	11,653	32,046	1,096	2,795	2,000	5,100	(y) 68,723	65,373
Slate ground as a pigment—long tons	2,000	24,000	2,000	24,000	2,000	20,000	1,975	24,687
Sulphur—short tons	600	21,000	1,000	27,000	500	12,000	715	17,875
Asphaltum—short tons	3,000	10,500	3,000	10,500	3,000	10,500	3,000	10,500
Corundum—short tons	500	6,250	(h)	....	(h)	....	....	....
Pumice-stone—short tons	70	1,750	....	....	....	....	....	....
Feldspar—long tons	(h)	....	14,100	71,112	10,900	55,112	13,600	68,000
Zinc-white—short tons	(h)	....	(h)	....	13,000	910,000	15,000	1,050,000
Bromine—pounds	(h)	....	301,100	72,264	281,100	67,464	310,000	89,900
Mineral waters—gallons sold	(h)	....	7,529,423	1,119,603	10,215,328	1,459,143	9,148,401	1,312,845
Natural gas	....	215,000	....	475,000	....	1,460,000	....	4,854,200
Total value non-metallic mineral products	....	$227,461,580	....	$241,049,889	....	$219,800,674	....	$239,431,991
Total value metallic products	....	219,755,109	....	203,116,859	....	186,414,074	....	181,589,365
Estimated value of mineral products unspecified (z)	....	8,000,000	....	8,000,000	....	7,000,000	....	7,500,000
Grand total	....	$455,216,689	....	$452,166,748	....	$413,214,748	....	$428,521,356

a. By "spot" value is meant value at the point of production.
b. "Long" tons are tons of 2,240 avoirdupois pounds; "short" tons are tons of 2,000 avoirdupois pounds.
c. $1.2929 per troy ounce.
d. $20.6718 per troy ounce.
e. Including copper made from imported pyrites.
f. Of 76¼ avoirdupois pounds net.
g. Including nickel in copper-nickel alloy.
h. Not reported.
i. Including brown coal and lignite, and small lots of anthracite mined elsewhere than in Pennsylvania.
j. The commercial product, that is, the amount marketed, was only 57,963,038 tons, worth $72,453,797.
k. The commercial product, that is, the amount marketed, was only 65,030,171 tons, worth $78,036,205.
l. The commercial product, that is, the amount marketed, was only 66,809,356 tons, worth $70,149,824.
m. The commercial product, that is, the amount marketed, was only 63,569,284 tons, valued at $80,640,564.
n. The commercial product, that is, the amount marketed, was only 29,120,096 tons, worth $65,520,216.
o. The commercial product, that is, the amount marketed, was only 31,793,027 tons, worth $71,534,311.
p. The commercial product, that is, the amount marketed, was only 30,718,293 tons, worth $61,436,586.
q. The commercial product, that is, the amount marketed, was only 32,265,421 tons, valued at $72,274,544.
r. Of 42 gallons.
s. From the Pennsylvania and New York fields only; the outside production was very small. For 1883, 1884, and 1885 the figures are complete for the whole United States.
t. Of 200 pounds.
u. Of 280 pounds net.
v. Of 300 pounds for natural cement, and 400 pounds for artificial Portland.
w. Year ending May 31.
x. Calendar year.
y. Including cobalt oxide in ore and matte.
z. Including, where not specified in the table, fire-clay, kaolin, potter's clay, common brick clay, terra cotta, building sand, glass sand, limestone used as flux in lead smelting, limestone in glass making, iron ore used as flux in lead smelting, marls (other than New Jersey), gypsum, tin ore, antimony, iridosmine, mill buhrstone and stone for making grindstones, novaculite, corundum, lithograph stone, talc and soapstone, quartz, feldspar, fluorspar, nitrate of soda, carbonate of soda, sulphate of soda, native alum, ozocerite, mineral soap, strontia, infusorial earth and tripoli, pumice-stone, sienna, umber, zinc-white, bromine, and mineral waters.

U. S. MINING LAWS.

An Act granting the right of way to ditch and canal owners, over the public lands, and for other purposes. (Approved July 26, 1866. U. S. Stats., v. 14, p. 251.)

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That the mineral lands of the public domain, both surveyed and unsurveyed, are hereby declared to be free and open to exploration and occupation by all citizens of the United States, and those who have declared their intention to become citizens, subject to such regulations as may be prescribed by law, and subject also to the local customs or rules of miners in the several mining districts, so far as the same may not be in conflict with the laws of the United States.

SEC. 2. *And be it further enacted,* That whenever any person, or association of persons, claim a vein or lode of quartz, or other rock in place, bearing gold, silver, cinnabar, or copper, having previously occupied or improved the same according to the local customs or rules of miners in the district where the same is situated, and having expended in actual labor and improvements thereon an amount not less than one thousand dollars, and in regard to whose possession there is no controversy or opposing claim, it shall and may be lawful for said claimant, or association of claimants, to file in the local Land Office a diagram of the same, so extended, laterally or otherwise, as to conform to the local laws, customs, and rules of miners, and to enter such tract and receive a patent therefor, granting such mine, together with the right to follow such vein or lode, with its dips, angles, and variations, to any depth, although it may enter the land adjoining, which land adjoining shall be sold subject to this condition.

SEC. 3. *And be it further enacted,* That, upon the filing of the diagram as provided in the second section of this Act, and posting the same in a conspicuous place on the claim, together with a notice of intention to apply for a patent, the Register of the Land Office shall publish a notice of the same in a newspaper published nearest to the location of said claim, and shall also post such notice in his office for the period of ninety days; and after the expiration of said period, if no adverse claim shall have been filed, it shall be the duty of the Surveyor-General, upon application of the party, to survey the premises and make a plat thereof, indorsed with his approval, designating the number and description of the location, the value of the labor and improvements, and the character of the vein exposed; and upon the payment to the proper officer of five dollars per acre, together with the cost of such survey, plat, and notice, and giving satisfactory evidence that said diagram and notice have been posted on the claim during said period of ninety days, the Register of the Land Office shall transmit to the General Land Office said plat, survey, and description, and a patent shall issue for the same thereupon. But said plat, survey, or description shall in no case cover more than one vein or lode, and no patent shall issue for more than one vein or lode, which shall be expressed in the patent issued.

SEC. 4. *And be it further enacted,* That when such location and entry of a mine shall be upon unsurveyed lands, it shall and may be lawful, after the extension thereto of the public surveys, to adjust the surveys to the limits of the premises according to the location and possession and

plat aforesaid; and the Surveyor-General may, in extending the surveys, vary the same from a rectangular form to suit the circumstances of the country and the local rules, laws, and customs of miners; *provided*, that no location hereafter made shall exceed two hundred feet in length along the vein for each locator, with an additional claim for discovery to the discoverer of the lode, with the right to follow such vein to any depth, with all its dips, variations, and angles, together with a reasonable quantity of surface for the convenient working of the same, as fixed by local rules; *and provided further*, that no person may make more than one location on the same lode, and not more than three thousand feet shall be taken in any one claim by any association of persons.

SEC. 5. *And be it further enacted*, That, as a further condition of sale, in the absence of necessary legislation by Congress, the local Legislature of any State or Territory may provide rules for working mines involving easements, drainage, and other necessary means to their complete development; and those conditions shall be fully expressed in the patent.

SEC. 6. *And be it further enacted*, That whenever any adverse claimants to any mine, located and claimed as aforesaid, shall appear before the approval of the survey, as provided in the third section of this Act, all proceedings shall be stayed until final settlement and adjudication, in the Courts of competent jurisdiction, of the rights of possession to such claim, when a patent may issue as in other cases.

SEC. 7. *And be it further enacted*, That the President of the United States be and is hereby authorized to establish additional land districts, and to appoint the necessary officers under existing laws, wherever he may deem the same necessary for the public convenience in executing the provisions of this Act.

SEC. 8. *And be it further enacted*, That the right of way for the construction of highways over public lands, not reserved for public uses, is hereby granted.

SEC. 9. *And be it further enacted*, That whenever, by priority of possession, rights to the use of water for mining, agricultural, manufacturing, or other purposes, have vested and accrued, and the same are recognized and acknowledged by the local customs, laws, and the decisions of Courts, the possessors and owners of such vested rights shall be maintained and protected in the same; and the right of way for the construction of ditches and canals for the purposes aforesaid is hereby acknowledged and confirmed; *provided, however*, that whenever, after the passage of this Act, any person or persons shall, in the construction of any ditch or canal, injure or damage the possession of any settler on the public domain, the party committing such injury or damage shall be liable to the party injured for such injury or damage.

SEC. 10. *And be it further enacted*, That wherever, prior to the passage of this Act, upon the lands heretofore designated as mineral lands, which have been excluded from survey and sale, there have been homesteads made by citizens of the United States, or persons who have declared their intention to become citizens, which homesteads have been made, improved, and used for agricultural purposes, and upon which there have been no valuable mines of gold, silver, cinnabar, or copper discovered, and which are properly agricultural lands, the said settlers or owners of such homesteads shall have a right of preëmption thereto, and shall be entitled to purchase the same at the price of one dollar and twenty-five cents per acre, and in quantity not to exceed one hundred and sixty acres; or said parties may avail themselves of the provisions of the Act of Congress, approved May twentieth, eighteen hundred and sixty-two, entitled "An Act

to secure homesteads to actual settlers on the public domain," and Acts amendatory thereof.

SEC. 11. *And be it further enacted*, That, upon the survey of the lands aforesaid, the Secretary of the Interior may designate and set apart such portion of the said lands as are clearly agricultural lands, which lands shall thereafter be subject to preëmption and sale as other public lands of the United States, and subject to all the laws and regulations applicable to the same.

An Act to amend "An Act granting the right of way to ditch and canal owners over the public lands, and for other purposes." (Approved July 9, 1870. U. S. Stats., v. 16, p. 217.)

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That the Act granting the right of way to ditch and canal owners over the public lands, and for other purposes, approved July twenty-sixth, eighteen hundred and sixty-six, be and the same is hereby amended, by adding thereto the following additional sections, numbered twelve, thirteen, fourteen, fifteen, sixteen, and seventeen, respectively, which shall hereafter constitute and form a part of the aforesaid Act:

SEC. 12. *And be it further enacted*, That claims, usually called "placers," including all forms of deposit, excepting veins of quartz, or other rock in place, shall be subject to entry and patent under this Act, under like circumstances and conditions, and upon similar proceedings, as are provided for vein or lode claims; *provided*, that where the lands have been previously surveyed by the United States, the entry in its exterior limits shall conform to the legal subdivisions of the public lands, no further survey or plat in such case being required, and the lands may be paid for at the rate of two dollars and fifty cents per acre; *provided further*, that legal subdivisions of forty acres may be subdivided into ten-acre tracts; and that two or more persons, or association of persons, having contiguous claims of any size, although such claims may be less than ten acres each, may make joint entry thereof; *and provided further*, that no location of a placer claim, hereafter made, shall exceed one hundred and sixty acres for any one person or association of persons, which location shall conform to the United States surveys; and nothing in this section contained shall defeat or impair any bona fide preëmption or homestead claim upon agricultural lands, or authorize the sale of the improvements of any bona fide settler to any purchaser.

SEC. 13. *And be it further enacted*, That where said person or association, they and their grantors, shall have held and worked their said claims for a period equal to the time prescribed by the statute of limitation for mining claims of the State or Territory where the same may be situated, evidence of such possession and working of the claims for such period, shall be sufficient to establish a right to a patent thereto under this Act, in the absence of any adverse claim; *provided, however*, that nothing in this Act shall be deemed to impair any lien which may have attached in any way whatever to any mining claim, or property thereto attached, prior to the issuance of a patent.

SEC. 14. *And be it further enacted*, That all ex parte affidavits required to be made under this Act, or the Act of which it is amendatory, may be verified before any officer authorized to administer oaths within the land district where the claims may be situated.

SEC. 15. *And be it further enacted*, That Registers and Receivers shall

receive the same fees for services under this Act, as are provided by law for like services under other Acts of Congress, and that effect shall be given to the foregoing Act according to such regulations as may be prescribed by the Commissioner of the General Land Office.

SEC. 16. *And be it further enacted*, That so much of the Act of March third, eighteen hundred and fifty-three, entitled "An Act to provide for the survey of the public lands in California, the granting of preëmption rights, and for other purposes," as provides that none other than township lines shall be surveyed where the lands are mineral, is hereby repealed, and the public surveys are hereby extended over all such land; *provided*, that all subdividing of surveyed lands into lots less than one hundred and sixty acres may be done by county and local surveyors at the expense of the claimants; *and provided further*, that nothing herein contained shall require the survey of waste or useless lands.

SEC. 17. *And be it further enacted*, That none of the rights conferred by sections five, eight, and nine of the Act to which this Act is amendatory shall be abrogated by this Act, and the same are hereby extended to all public lands affected by this Act; and all patents granted, or preëmption or homesteads allowed, shall be subject to any vested and accrued water rights, or rights to ditches and reservoirs used in connection with such water rights as may have been acquired under or recognized by the ninth section of the Act of which this Act is amendatory. But nothing in this Act shall be construed to repeal, impair, or in any way affect the provisions of the "Act granting to A. Sutro the right of way and other privileges to aid in the construction of a draining and exploring tunnel to the Comstock lode, in the State of Nevada," approved July twenty-fifth, eighteen hundred and sixty-six.

UNITED STATES MINING LAWS, AND REGULATIONS THEREUNDER.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE, October 29, 1881.

GENTLEMEN: Your attention is invited to the Revised Statutes of the United States and the amendments thereto in regard to mining laws and mining resources. Title XXXII, Chapter VI.

SECTION 2318. In all cases lands valuable for minerals shall be reserved from sale, except as otherwise expressly directed by law.

SEC. 2319. All valuable mineral deposits in lands belonging to the United States, both surveyed and unsurveyed, are hereby declared to be free and open to exploration and purchase, and the lands in which they are found to occupation and purchase, by citizens of the United States and those who have declared their intention to become such, under regulations prescribed by law, and according to the local customs or rules of miners in the several mining districts, so far as the same are applicable and not inconsistent with the laws of the United States.

SEC. 2320. Mining claims upon veins or lodes of quartz or other rock in place bearing gold, silver, cinnabar, lead, tin, copper, or other valuable deposits, heretofore located, shall be governed as to length along the vein or lode by the customs, regulations, and laws in force at the date of their location. A mining claim located after the tenth day of May, eighteen hundred and seventy-two, whether located by one or more persons, may

equal, but shall not exceed, one thousand five hundred feet in length along the vein or lode; but no location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located. No claim shall extend more than three hundred feet on each side of the middle of the vein at the surface, nor shall any claim be limited by any mining regulation to less than twenty-five feet on each side of the middle of the vein at the surface, except where adverse rights existing on the tenth day of May, eighteen hundred and seventy-two, render such limitation necessary. The end lines of each claim shall be parallel to each other.

SEC. 2321. Proof of citizenship, under this chapter, may consist, in the case of an individual, of his own affidavit thereof; in the case of an association of persons unincorporated, of the affidavit of their authorized agent, made on his own knowledge, or upon information and belief; and in the case of a corporation organized under the laws of the United States, or of any State or Territory thereof, by the filing of a certified copy of their charter or certificate of incorporation.

SEC. 2322. The locators of all mining locations heretofore made or which shall hereafter be made, on any mineral vein, lode, or ledge, situated on the public domain, their heirs and assigns, where no adverse claim exists on the tenth day of May, eighteen hundred and seventy-two, so long as they comply with the laws of the United States, and with the State, Territorial, and local regulations not in conflict with the laws of the United States governing their possessory title, shall have the exclusive right of possession and enjoyment of all the surface included within the lines of their locations, and of all veins, lodes, and ledges throughout their entire depth, the top or apex of which lies inside of such surface lines extended downward vertically, although such veins, lodes, or ledges may so far depart from a perpendicular in their course downward as to extend outside the vertical side-lines of such surface locations. But their right of possession to such outside parts of such veins or ledges shall be confined to such portions thereof as lie between vertical planes drawn downward as above described, through the end-lines of their locations, so continued in their own direction that such planes will intersect such exterior parts of such veins or ledges. And nothing in this section shall authorize the locator or possessor of a vein or lode which extends in its downward course beyond the vertical lines of his claim to enter upon the surface of a claim owned or possessed by another.

SEC. 2323. Where a tunnel is run for the development of a vein or lode, or for the discovery of mines, the owners of such tunnel shall have the right of possession of all veins or lodes within three thousand feet from the face of such tunnel on the line thereof, not previously known to exist, discovered in such tunnel, to the same extent as if discovered from the surface; and locations on the line of such tunnel of veins or lodes not appearing on the surface, made by other parties after the commencement of the tunnel, and while the same is being prosecuted with reasonable diligence, shall be invalid; but failure to prosecute the work on the tunnel for six months shall be considered as an abandonment of the right to all undiscovered veins on the line of such tunnel.

SEC. 2324. The miners of each mining district may make regulations not in conflict with the laws of the United States, or with the laws of the State or Territory in which the district is situated, governing the location, manner of recording, amount of work necessary to hold possession of a mining claim, subject to the following requirements: The location must be distinctly marked on the ground so that its boundaries can be readily traced. All records of mining claims hereafter made shall contain the

name or names of the locators, the date of the location, and such a description of the claim or claims located by reference to some natural object or permanent monument as will identify the claim. On each claim located after the tenth day of May, eighteen hundred and seventy-two, and until a patent has been issued therefor, not less than one hundred dollars' worth of labor shall be performed or improvements made during each year. On all claims located prior to the tenth day of May, eighteen hundred and seventy-two, ten dollars' worth of labor shall be performed or improvements made by the tenth day of June, eighteen hundred and seventy-four, and each year thereafter, for each one hundred feet in length along the vein until a patent has been issued therefor; but where such claims are held in common, such expenditure may be made upon any one claim; and upon a failure to comply with these conditions, the claim or mine upon which such failure occurred shall be open to relocation in the same manner as if no location of the same had ever been made, provided that the original locators, their heirs, assigns, or legal representatives, have not resumed work upon the claim after failure and before such location. Upon the failure of any one of several coöwners to contribute his proportion of the expenditures required hereby, the coöwners who have performed the labor or made the improvements may, at the expiration of the year, give such delinquent coöwner personal notice in writing, or notice by publication in the newspaper published nearest the claim, for at least once a week for ninety days, and if at the expiration of ninety days after such notice in writing or by publication such delinquent should fail or refuse to contribute his proportion of the expenditure required by this section, his interest in the claim shall become the property of his coöwners who have made the required expenditures.

Sec. 2325. A patent for any land claimed and located for valuable deposits may be obtained in the following manner: Any person, association, or corporation authorized to locate a claim under this chapter, having claimed and located a piece of land for such purposes, who has, or have complied with the terms of this chapter, may file in the proper Land Office an application for a patent, under oath, showing such compliance, together with a plat and field-notes of the claim or claims in common, made by or under the direction of the United States Surveyor-General, showing accurately the boundaries of the claim or claims, which shall be distinctly marked by monuments on the ground, and shall post a copy of such plat, together with a notice of such application for a patent, in a conspicuous place on the land embraced in such plat previous to the filing of the application for a patent, and shall file an affidavit of at least two persons that such notice has been duly posted, and shall file a copy of the notice in such Land Office, and shall thereupon be entitled to a patent for the land, in the manner following: The Register of the Land Office, upon the filing of such application, plat, field-notes, notices, and affidavits, shall publish a notice that such application has been made, for the period of sixty days, in a newspaper to be by him designated as published nearest to such claim; and he shall also post such notice in his office for the same period. The claimant at the time of filing this application, or at any time thereafter, within the sixty days of publication, shall file with the Register a certificate of the United States Surveyor-General that five hundred dollars' worth of labor has been expended or improvements made upon the claim by himself or grantors; that the plat is correct, with such further description by such reference to natural objects or permanent monuments as shall identify the claim, and furnish an accurate description, to be incorporated in the patent. At the expiration of the sixty days of publication

the claimant shall file his affidavit, showing that the plat and notice have been posted in a conspicuous place on the claim during such period of publication. If no adverse claim shall have been filed with the Register and the Receiver of the proper Land Office at the expiration of the sixty days of publication, it shall be assumed that the applicant is entitled to a patent, upon the payment to the proper officer of five dollars per acre, and that no adverse claim exists; and thereafter no objection from third parties to the issuance of a patent shall be heard, except it be shown that the applicant has failed to comply with the terms of this chapter.

SEC. 2326. Where an adverse claim is filed during the period of publication, it shall be upon oath of the person or persons making the same, and shall show the nature, boundaries, and extent of such adverse claim, and all proceedings, except the publication of notice and making and filing of the affidavit thereof, shall be stayed until the controversy shall have been settled or decided by a Court of competent jurisdiction, or the adverse claim waived. It shall be the duty of the adverse claimant, within thirty days after filing his claim, to commence proceedings in a Court of competent jurisdiction, to determine the question of the right of possession, and prosecute the same with reasonable diligence to final judgment; and a failure so to do shall be a waiver of his adverse claim. After such judgment shall have been rendered, the party entitled to the possession of the claim, or any portion thereof, may, without giving further notice, file a certified copy of the judgment-roll with the Register of the Land Office, together with the certificate of the Surveyor-General, that the requisite amount of labor has been expended, or improvements made thereon; and the description required in other cases, and shall pay to the Receiver five dollars per acre for his claim, together with the proper fees, whereupon the whole proceedings and the judgment-roll shall be certified by the Register to the Commissioner of the General Land Office, and a patent shall issue thereon for the claim, or such portion thereof as the applicant shall appear, from the decision of the Court, to rightly possess. If it appears from the decision of the Court that several parties are entitled to separate and different portions of the claim, each party may pay for his portion of the claim, with the proper fees, and file the certificate and description by the Surveyor-General, whereupon the Register shall certify the proceedings and judgment-roll to the Commissioner of the General Land Office, as in the preceding case, and patents shall issue to the several parties, according to their respective rights. Nothing herein contained shall be construed to prevent the alienation of a title conveyed by a patent for a mining claim to any person whatever.

SEC. 2327. The description of vein or lode claims, upon surveyed lands, shall designate the location of the claim with reference to the lines of the public surveys, but need not conform therewith; but where a patent shall be issued for claims upon unsurveyed lands, the Surveyor-General, in extending the surveys, shall adjust the same to the boundaries of such patented claim, according to the plat or description thereof, but so as in no case to interfere with or change the location of any such patented claim.

SEC. 2328. Applications for patents for mining claims under former laws now pending may be prosecuted to a final decision in the General Land Office; but in such cases, where adverse rights are not affected thereby, patents may issue in pursuance of the provisions of this chapter; and all patents for mining claims upon veins or lodes heretofore issued shall convey all the rights and privileges conferred by this chapter where

no adverse rights existed on the tenth day of May, eighteen hundred and seventy-two.

SEC. 2329. Claims usually called "placers," including all forms of deposit, excepting veins of quartz or other rock in place, shall be subject to entry and patent, under like circumstances and conditions, and upon similar proceedings, as are provided for vein or lode claims; but where the lands have been previously surveyed by the United States, the entry in its exterior limits shall conform to the legal subdivisions of the public lands.

SEC. 2330. Legal subdivisions of forty acres may be subdivided into ten-acre tracts; and two or more persons, or associations of persons, having contiguous claims of any size, although such claims may be less than ten acres each, may make joint entry thereof; but no location of a placer claim, made after the ninth day of July, eighteen hundred and seventy, shall exceed one hundred and sixty acres for any one person or association of persons, which location shall conform to the United States surveys; and nothing in this section contained shall defeat or impair any bona fide preemption or homestead claim upon agricultural lands, or authorize the sale of the improvements of any bona fide settler to any purchaser.

SEC. 2331. Where placer claims are upon surveyed lands, and conform to legal subdivisions, no further survey or plat shall be required, and all placer mining claims located after the tenth day of May, eighteen hundred and seventy-two, shall conform as near as practicable with the United States system of public land surveys, and the rectangular subdivisions of such surveys, and no such location shall include more than twenty acres for each individual claimant; but where placer claims cannot be conformed to legal subdivisions, survey and plat shall be made as on unsurveyed lands; and where by the segregation of mineral lands in any legal subdivision a quantity of agricultural land less than forty acres remains, such fractional portion of agricultural land may be entered, by any party qualified by law, for homestead or preëmption purposes.

SEC. 2332. Where such person or association, they or their grantors, have held and worked their claims for a period equal to the time prescribed by the statute of limitations for mining claims of the State or Territory where the same may be situated, evidence of such possession and working of the claims for such period shall be sufficient to establish a right to a patent thereto under this chapter, in the absence of any adverse claim; but nothing in this chapter shall be deemed to impair any lien which may have attached in any way whatever to any mining claim or property thereto attached prior to the issuance of a patent.

SEC. 2333. Where the same person, association, or corporation is in possession of a placer claim, and also a vein or lode included within the boundaries thereof, application shall be made for a patent for the placer claim, with the statement that it includes such vein or lode, and in such case a patent shall issue for the placer claim, subject to the provisions of this chapter, including such vein or lode, upon the payment of five dollars per acre for such vein or lode claim, and twenty-five feet of surface on each side thereof. The remainder of the placer claim, or any placer claim not embracing any vein or lode claim, shall be paid for at the rate of two dollars and fifty cents per acre, together with all costs of proceedings; and where a vein or lode, such as is described in section twenty-three hundred and twenty, is known to exist within the boundaries of a placer claim, an application for a patent for such placer claim which does not include an application for the vein or lode claim shall be construed as a conclusive declaration that the claimant of the placer claim has no right of possession

of the vein or lode claim; but where the existence of a vein or lode in a placer claim is not known, a patent for the placer claim shall convey all valuable mineral and other deposits within the boundaries thereof.

SEC. 2334. The Surveyor-General of the United States may appoint in each land district containing mineral lands as many competent surveyors as shall apply for appointment to survey mining claims. The expenses of the survey of vein or lode claims, and the survey and subdivision of placer claims into smaller quantities than one hundred and sixty acres, together with the cost of publication of notices, shall be paid by the applicants, and they shall be at liberty to obtain the same at the most reasonable rates, and they shall also be at liberty to employ any United States Deputy Surveyor to make the survey. The Commissioner of the General Land Office shall also have power to establish the maximum charges for surveys and publication of notices under this chapter; and, in case of excessive charges for publication, he may designate any newspaper published in a land district where mines are situated, for the publication of mining notices in such district, and fix the rates to be charged by such paper; and, to the end that the Commissioner may be fully informed on the subject, each applicant shall file with the Register a sworn statement of all charges and fees paid by such applicant for publication and surveys, together with all fees and money paid the Register and the Receiver of the Land Office, which statement shall be transmitted, with the other papers in the case, to the Commissioner of the General Land Office.

SEC. 2335. All affidavits required to be made under this chapter may be verified before any officer authorized to administer oaths within the land district where the claims may be situated, and all testimony and proofs may be taken before any such officer, and, when duly certified by the officer taking the same, shall have the same force and effect as if taken before the Register and Receiver of the Land Office. In cases of contest as to the mineral or agricultural character of the land, the testimony and proofs may be taken as herein provided, on personal notice of at least ten days to the opposing party; or, if such party cannot be found, then by publication of at least once a week for thirty days, in a newspaper to be designated by the Register of the Land Office, as published nearest to the location of such land; and the Register shall require proof that such notice has been given.

SEC. 2336. Where two or more veins intersect or cross each other, priority of title shall govern; and such prior location shall be entitled to all ore or mineral contained within the space of intersection; but the subsequent location shall have the right of way through the space of intersection, for the purposes of the convenient working of the mine. And where two or more veins unite, the oldest or prior location shall take the vein below the point of union, including all the space of intersection.

SEC. 2337. Where non-mineral land, not contiguous to the vein or lode, is used or occupied by the proprietor of such vein or lode for mining or milling purposes, such non-adjacent surface ground may be embraced and included in an application for a patent for such vein or lode, and the same may be patented therewith, subject to the same preliminary requirements as to survey and notice as are applicable to veins or lodes; but no location hereafter made of such non-adjacent land shall exceed five acres, and payment for the same must be made at the same rate as fixed by this chapter for the superficies of the lode. The owner of a quartz mill or reduction works, not owning a mine in connection therewith, may also receive a patent for his mill site, as provided in this section.

SEC. 2338. As a condition of sale, in the absence of necessary legisla-

tion by Congress, the local Legislature of any State or Territory may provide rules for working mines, involving easements, drainage, and other necessary means to their complete development; and those conditions shall be fully expressed in the patent.

SEC. 2339. Whenever, by priority of possession, rights to the use of water for mining, agricultural, manufacturing, or other purposes, have vested and accrued, and the same are recognized and acknowledged by the local customs, laws, and the decisions of Courts, the possessors and owners of such vested rights shall be maintained and protected in the same; and the right of way for the construction of ditches and canals for the purposes herein specified is acknowledged and confirmed; but whenever any person, in the construction of any ditch or canal, injures or damages the possession of any settler on the public domain, the party committing such injury or damage shall be liable to the party injured for such injury or damage.

SEC. 2340. All patents granted, or preëmption or homesteads allowed, shall be subject to any vested and accrued water-rights, or rights to ditches and reservoirs used in connection with such water-rights, as may have been acquired under or recognized by the preceding section.

SEC. 2341. Wherever, upon the lands heretofore designated as mineral lands, which have been excluded from survey and sale, there have been homesteads made by citizens of the United States, or persons who have declared their intention to become citizens, which homesteads have been made, improved, and used for agricultural purposes, and upon which there have been no valuable mines of gold, silver, cinnabar, or copper discovered, and which are properly agricultural lands, the settlers or owners of such homesteads shall have a right of preëmption thereto, and shall be entitled to purchase the same at the price of one dollar and twenty-five cents per acre, and in quantity not to exceed one hundred and sixty acres; or they may avail themselves of the provisions of chapter five of this title, relating to "homesteads."

SEC. 2342. Upon the survey of the lands described in the preceding section, the Secretary of the Interior may designate and set apart such portions of the same as are clearly agricultural lands, which lands shall thereafter be subject to preëmption and sale as other public lands, and be subject to all the laws and regulations applicable to the same.

SEC. 2343. The President is authorized to establish additional land districts, and to appoint the necessary officers under existing laws, wherever he may deem the same necessary for the public convenience in executing the provisions of this chapter.

SEC. 2344. Nothing contained in this chapter shall be construed to impair, in any way, rights or interests in mining property acquired under existing laws; nor to affect the provisions of the Act entitled "an Act granting to A. Sutro the right of way and other privileges to aid in the construction of a draining and exploring tunnel to the Comstock lode, in the State of Nevada," approved July twenty-fifth, eighteen hundred and sixty-six.

SEC. 2345. The provisions of the preceding sections of this chapter shall not apply to the mineral lands situated in the States of Michigan, Wisconsin, and Minnesota, which are declared free and open to exploration and purchase according to legal subdivisions, in like manner as before the tenth day of May, eighteen hundred and seventy-two. And any bona fide entries of such lands within the States named since the tenth of May, eighteen hundred and seventy-two, may be patented without reference to any of the foregoing provisions of this chapter. Such lands shall be

offered for public sale in the same manner, at the same minimum price, and under the same rights of preëmption, as other public lands.

SEC. 2346. No Act passed at the first session of the thirty-eighth Congress, granting lands to States or corporations to aid in the construction of roads, or for other purposes, or to extend the time of grants made prior to the thirtieth day of January, eighteen hundred and sixty-five, shall be so construed as to embrace mineral lands, which in all cases are reserved exclusively to the United States, unless otherwise specially provided in the Act or Acts making the grant.

REPEAL PROVISIONS.

TITLE LXXIV.

SEC. 5595. The foregoing seventy-three titles embrace the statutes of the United States, general and permanent in their nature, in force on the first day of December, one thousand eight hundred and seventy-three, as revised and consolidated by Commissioners appointed under an Act of Congress, and the same shall be designated and cited as the revised statutes of the United States.

SEC. 5596. All Acts of Congress passed prior to said first day of December, one thousand eight hundred and seventy-three, any portion of which is embraced in any section of said revision, are hereby repealed, and the section applicable thereto shall be in force in lieu thereof; all parts of such Acts not contained in such revision, having been repealed or superseded by subsequent Acts, or not being general and permanent in their nature; *provided*, that the incorporation into such revision of any general and permanent provision, taken from an Act making appropriations, or from an Act containing other provisions of a private, local, or temporary character, shall not repeal, or in any way affect any appropriation, or any provision of a private, local, or temporary character, contained in any of said Acts, but the same shall remain in force; and all Acts of Congress passed prior to said last named day, no part of which are embraced in said revision, shall not be affected or changed by its enactments.

SEC. 5597. The repeal of the several Acts embraced in said revision shall not affect any act done, or any right accruing or accrued, or any suit or proceeding had or commenced in any civil cause before the said repeal. but all rights and liabilities under said Acts shall continue, and may be enforced in the same manner, as if said repeal had not been made; nor shall said repeal in any manner affect the right to any office, or change the term or tenure thereof.

SEC. 5598. All offenses committed and all penalties or forfeitures incurred under any statute embraced in said revision prior to said repeal, may be prosecuted and punished in the same manner and with the same effect, as if said repeal had not been made.

SEC. 5599. All acts of limitation, whether applicable to civil causes and proceedings, or to the prosecution of offenses, or for the recovery of penalties or forfeitures, embraced in said revision and covered by said repeal, shall not be affected thereby, but all suits, proceedings, or prosecutions, whether civil or criminal, for causes arising, or acts done or committed prior to said repeal, may be commenced and prosecuted within the same time as if said repeal had not been made.

SEC. 5600. The arrangement and classification of the several sections of the revision have been made for the purpose of a more convenient and

orderly arrangement of the same, and therefore no inference or presumption of a legislative construction is to be drawn by reason of the title under which any particular section is placed.

SEC. 5601. The enactment of the said revision is not to affect or repeal any Act of Congress passed since the first day of December, one thousand eight hundred and seventy-three, and all Acts passed since that date are to have full effect as if passed after the enactment of this revision, and so far as such Acts vary from, or conflict with any provision contained in said revision, they are to have effect as subsequent statutes, and as repealing any portion of the revision inconsistent therewith.

Approved June 22, 1874.

The following is an Act of Congress approved June 6, 1874:

An Act to amend the Act entitled "An Act to promote the development of the mining resources of the United States," passed May tenth, eighteen hundred and seventy-two.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That the provisions of the fifth section of the Act entitled "An Act to promote the development of the mining resources of the United States," passed May tenth, eighteen hundred and seventy-two, which requires expenditures of labor and improvements on claims located prior to the passage of said Act, are hereby so amended that the time for the first annual expenditure on claims located prior to the passage of said Act shall be extended to the first day of January, eighteen hundred and seventy-five.

The following is an Act of Congress approved February 11, 1875:

An Act to amend section two thousand three hundred and twenty-four of the Revised Statutes, relating to the development of the mining resources of the United States.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That section two thousand three hundred and twenty-four of the Revised Statutes be and the same is hereby amended so that where a person or company has or may run a tunnel for the purposes of developing a lode or lodes, owned by said person or company, the money so expended in said tunnel shall be taken and considered as expended on said lode or lodes, whether located prior to or since the passage of said Act, and such person or company shall not be required to perform work on the surface of said lode or lodes in order to hold the same as required by said Act.

The following is an Act of Congress approved May 5, 1876:

An Act to exclude the States of Missouri and Kansas from the provisions of the Act of Congress entitled "An Act to promote the development of the mining resources of the United States," approved May tenth, eighteen hundred and seventy-two.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That within the States of Missouri and Kansas, deposits of coal, iron, lead, or other mineral be and they are hereby excluded from the operation of the Act entitled "An Act to promote the development of the mining resources of the United States," ap-

proved May tenth, eighteen hundred and seventy-two, and all lands in said States shall be subject to disposal as agricultural lands.

The following is an Act of Congress approved June 3, 1878:

An Act authorizing the citizens of Colorado, Nevada, and the Territories to fell and remove timber on the public domain for mining and domestic purposes.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That all citizens of the United States and other persons, bona fide residents of the State of Colorado or Nevada, or either of the Territories of New Mexico, Arizona, Utah, Wyoming, Dakota, Idaho, or Montana, and all other mineral districts of the United States, shall be and are hereby authorized and permitted to fell and remove, for building, agricultural, mining, or other domestic purposes, any timber or other trees growing or being on the public lands, said lands being mineral, and not subject to entry under existing laws of the United States, except for mineral entry, in either of said States, Territories, or districts of which such citizens or persons may be at the time bona fide residents, subject to such rules and regulations as the Secretary of the Interior may prescribe for the protection of the timber and of the undergrowth growing upon such lands, and for other purposes; *provided*, the provisions of this Act shall not extend to railroad corporations.

Sec. 2. That it shall be the duty of the Register and the Receiver of any local Land Office in whose district any mineral land may be situated, to ascertain from time to time whether any timber is being cut or used upon any such lands, except for the purposes authorized by this Act, within their respective land districts; and, if so, they shall immediately notify the Commissioner of the General Land Office of that fact; and all necessary expenses incurred in making such proper examinations shall be paid and allowed such Register and Receiver in making up their next quarterly accounts.

Sec. 3. Any person or persons who shall violate the provisions of this Act, or any rules and regulations in pursuance thereof made by the Secretary of the Interior, shall be deemed guilty of a misdemeanor, and, upon conviction, shall be fined in any sum not exceeding five hundred dollars, and to which may be added imprisonment for any term not exceeding six months.

The following is an Act of Congress approved January 22, 1880:

An Act to amend sections twenty-three hundred and twenty-four and twenty-three hundred and twenty-five of the Revised Statutes of the United States concerning mineral lands.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That section twenty-three hundred and twenty-five of the Revised Statutes of the United States be amended by adding thereto the following words: "*Provided*, that where the claimant for a patent is not a resident of or within the land district wherein the vein, lode, ledge, or deposit sought to be patented is located, the application for patent and the affidavits required to be made in this section by the claimant for such patent may be made by his, her, or its authorized agent, where said agent is conversant with the facts sought to be established by said affidavits; *and provided*, that this section shall apply to all applications now pending for patents to mineral lands."

SEC. 2. That section twenty-three hundred and twenty-four of the Revised Statutes of the United States be amended by adding the following words: "*Provided*, that the period within which the work required to be done annually on all unpatented mineral claims shall commence on the first day of January succeeding the date of location of such claim, and this section shall apply to all claims located since the tenth day of May, Anno Domini eighteen hundred and seventy-two."

The following is an Act of Congress approved March 3, 1881:

An Act to amend section twenty-three hundred and twenty-six of the Revised Statutes of the United States, relating to suits at law affecting the title to mining claims.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That if, in any action brought pursuant to section twenty-three hundred and twenty-six of the Revised Statutes, title to the ground in controversy shall not be established by either party, the jury shall so find, and judgment shall be entered according to the verdict. In such case costs shall not be allowed to either party, and the claimant shall not proceed in the Land Office or be entitled to a patent for the ground in controversy until he shall have perfected his title.

REGULATIONS.

MINERAL LANDS OPEN TO EXPLORATION, OCCUPATION, AND PURCHASE.

1. It will be perceived that by the foregoing provisions of law the mineral lands in the public domain, surveyed or unsurveyed, are open to exploration, occupation, and purchase by all citizens of the United States, and all those who have declared their intentions to become such.

STATUS OF LODE-CLAIMS LOCATED PRIOR TO MAY TENTH, EIGHTEEN HUNDRED AND SEVENTY-TWO.

2. By an examination of the several sections of the Revised Statutes, it will be seen that the *status* of lode-claims located *previous* to the tenth of May, 1872, is not changed with regard to their *extent along the lode or width of surface.*

3. Mining rights acquired under such previous locations are, however, enlarged by said Revised Statutes in the following respect, viz.: The locators of all such previously taken veins or lodes, their heirs and assigns, so long as they comply with the laws of Congress and with State, Territorial, or local regulations not in conflict therewith, governing mining claims, are invested with the exclusive possessory right of all the surface included within the lines of their locations, and of all veins, lodes, or ledges throughout their entire depth, the top or apex of which lies inside of such surface lines extended downward vertically, although such veins, lodes, or ledges may so far depart from a perpendicular in their course downward as to extend outside the vertical side lines of such locations at the surface, it being expressly provided, however, that the right of possession to such outside parts of said veins or ledges shall be confined to such portions thereof as lie between vertical planes drawn downward as aforesaid, through the end lines of their locations so continued in their own direction that

such planes will intersect such exterior parts of such veins, lodes, or ledges; no right being granted, however, to the claimant of such outside portion of a vein or ledge to enter upon the surface location of another claimant.

4. It is to be distinctly understood, however, that the law limits the possessory right to veins, lodes, or ledges, *other* than the one named in the original location, to such as were not *adversely claimed on May 10, 1872*, and that where such other vein or ledge was so adversely claimed at that date, the right of the party so adversely claiming is in no way impaired by the provisions of the Revised Statutes.

5. In order to hold the possessory title to a mining claim located prior to May 10, 1872, and for which a patent has not been issued, the law requires that *ten dollars* shall be expended annually in labor or improvements on each claim of *one hundred feet* on the course of the vein or lode until a patent shall have been issued therefor; but where a number of such claims are held in common upon the same vein or lode, the aggregate expenditure that would be necessary to hold all the claims, at the rate of ten dollars per hundred feet, may be made upon any one claim; a failure to comply with this requirement in any one year subjecting the claim upon which such failure occurred to relocation by other parties, the same as if no previous location thereof had ever been made, unless the claimants under the original location shall have resumed work thereon, after such failure and before such relocation. The first annual expenditure upon claims of this class should have been performed subsequent to May 10, 1872, and prior to January 1, 1875. From and after January 1, 1875, the required amount must be expended *annually* until patent issues. By decision of the honorable Secretary of the Interior, dated March 4, 1879, such annual expenditures are not required subsequent to entry, the date of issuing the patent certificate being the date contemplated by statute.

6. Upon the failure of any one of several coöwners of a vein, lode, or ledge, which has not been entered, to contribute his proportion of the expenditures necessary to hold the claim or claims so held in ownership in common, the coöwners who have performed the labor, or made the improvements, as required by said Revised Statutes, may, at the expiration of the year, give such delinquent coöwner personal notice in writing, or notice by publication in the newspaper published nearest the claim, for at least once a week for ninety days; and, if upon the expiration of ninety days after such notice in writing, or upon the expiration of one hundred and eighty days after the first newspaper publication of notice, the delinquent coöwner shall have failed to contribute his proportion to meet such expenditures or improvements, his interest in the claim by law passes to his coöwners, who have made the expenditures or improvements as aforesaid. Where a claimant alleges ownership of a forfeited interest under the foregoing provision, the sworn statement of the publisher as to the facts of publication, giving dates and a printed copy of the notice published, should be furnished, and the claimant must swear that the delinquent coöwner failed to contribute his proper proportion within the period fixed by the statute.

PATENTS FOR VEINS OR LODES HERETOFORE ISSUED.

7. Rights under patents for veins or lodes heretofore granted under previous legislation of Congress are enlarged by the Revised Statutes so as to invest the patentee, his heirs or assigns, with title to all veins, lodes, or ledges, throughout their entire depth, the top or apex of which lies within the end and side boundary lines of his claim on the surface, as patented, extending downward vertically, although such veins, lodes, or ledges may

so far depart from a perpendicular in their course downward as to extend outside the vertical side lines of the claim at the surface. The right of possession to such outside parts of such veins or ledges to be confined to such portions thereof as lie between vertical planes drawn downward through the end lines of the claims at the surface, so continued in their own direction that such planes will intersect such exterior parts of such veins or ledges, it being expressly provided, however, that all veins, lodes, or ledges, the top or apex of which lies inside such surface locations, *other* than the one named in the patent, which were *adversely claimed on the tenth May, 1872*, are excluded from such conveyance by patent.

8. Applications for patents for mining claims pending at the date of the Act of May 10, 1872, may be prosecuted to final decision in the General Land Office, and where no adverse rights are affected thereby, patents will be issued in pursuance of the provisions of the Revised Statutes.

MANNER OF LOCATING CLAIMS ON VEINS OR LODES AFTER MAY TENTH, EIGHTEEN HUNDRED AND SEVENTY-TWO.

9. From and after the tenth May, 1872, any person who is a citizen of the United States, or who has declared his intention to become a citizen, may locate, record, and hold a mining claim of *fifteen hundred linear feet* along the course of any mineral vein or lode subject to location; or an association of persons, severally qualified as above, may make joint location of such claim of *fifteen hundred feet*, but in no event can a location of a vein or lode made subsequent to May 10, 1872, exceed fifteen hundred feet along the course thereof, whatever may be the number of persons composing the association.

10. With regard to the extent of surface-ground adjoining a vein or lode, and claimed for the convenient working thereof, the Revised Statutes provide that the lateral extent of locations of veins or lodes made after May 10, 1872, shall in no case *exceed three hundred feet on each side of the middle of the vein at the surface*, and that no such surface rights shall be limited by any mining regulations to less than twenty-five feet on each side of the middle of the vein at the surface, except where adverse rights existing on the tenth May, 1872, may render such limitation necessary; the end-lines of such claims to be in all cases parallel to each other. Said lateral measurements cannot extend beyond three hundred feet on *either* side of the middle of the vein at the surface, or such distance as is allowed by local laws. For example: Four hundred feet cannot be taken on one side and two hundred feet on the other. If, however, three hundred feet on each side are allowed, and by reason of prior claims but one hundred feet can be taken on one side, the locator will not be restricted to less than three hundred feet on the other side; and when the locator does not determine by exploration *where* the middle of the vein at the surface is, his discovery shaft must be assumed to mark such point.

11. By the foregoing it will be perceived that no lode-claim located after the tenth May, 1872, can exceed a parallelogram fifteen hundred feet in length by six hundred feet in width, but whether surface-ground of that width can be taken, depends upon the local regulations or State or Territorial laws in force in the several mining districts; and that no such local regulations or State or Territorial laws shall limit a vein or lode claim to less than fifteen hundred feet along the course thereof, whether the location is made by one or more persons, nor can surface rights be limited to less than fifty feet in width, unless adverse claims existing on the tenth day of May, 1872, render such lateral limitation necessary.

12. It is provided by the Revised Statutes that the miners of each district may make rules and regulations not in conflict with the laws of the United States, or of the State or Territory in which such districts are respectively situated, governing the location, manner of recording, and amount of work necessary to hold possession of a claim. They likewise require that the location shall be so distinctively marked on the ground that its boundaries may be readily traced. This is a very important matter, and locators cannot exercise too much care in defining their locations at the outset, inasmuch as the law requires that all records of mining locations made subsequent to May 10, 1872, shall contain the name or names of the locators, the date of the location, and such a *description of the claim or claims* located, by reference to some natural object or permanent monument, as will identify the claim.

13. The statutes provide that no lode-claim shall be recorded until after the discovery of a vein or lode within the limits of the claim located, the object of which provision is evidently to prevent the appropriation of presumed mineral ground for speculative purposes to the exclusion of *bona fide* prospectors, before sufficient work has been done to determine whether a vein or lode really exists.

14. The claimant should, therefore, prior to locating his claim, unless the vein can be traced upon the surface, sink a shaft, or run a tunnel or drift, to a sufficient depth therein to discover and develop a mineral-bearing vein, lode, or crevice; should determine, if possible, the general course of such vein in either direction from the point of discovery, by which direction he will be governed in marking the boundaries of his claim on the surface. His location notice should give the course and distance as nearly as practicable from the discovery-shaft on the claim, to some permanent, well known points or objects, such, for instance, as stone monuments, blazed trees, the confluence of streams, point of intersection of well known gulches, ravines, or roads, prominent buttes, hills, etc., which may be in the immediate vicinity, and which will serve to perpetuate and fix the *locus* of the claim and render it susceptible of identification from the description thereof given in the record of locations in the district, and should be duly recorded.

15. In addition to the foregoing data, the claimant should state the names of adjoining claims, or if none adjoin, the relative positions of the nearest claims; should drive a post or erect a monument of stones at each corner of his surface ground, and at the point of discovery or discovery shaft should fix a post, stake, or board, upon which should be designated the name of the lode, the name or names of the locators, the number of feet claimed, and in which direction from the point of discovery, it being essential that the location notice filed for record, in addition to the foregoing description, should state whether the entire claim of fifteen hundred feet is taken on one side of the point of discovery, or whether it is partly upon one and partly upon the other side thereof, and in the latter case, how many feet are claimed upon each side of such discovery point.

16. Within a reasonable time, say twenty days after the location shall have been marked on the ground, or such time as is allowed by the local laws, notice thereof, accurately describing the claim in manner aforesaid, should be filed for record with the proper Recorder of the district, who will thereupon issue the usual certificate of location.

17. In order to hold the possessory right to a location made since May 10, 1872, not less than one hundred dollars' worth of labor must be performed, or improvements made thereon annually until entry shall have been made. Under the provisions of the Act of Congress approved Jan-

uary 22, 1880, the first annual expenditure becomes due and must be performed during the calendar year succeeding that in which the location was made. Expenditure made or labor performed prior to the first day of January succeeding the date of location will not be considered as a part of, or applied upon the first annual expenditure required by law. Failure to make the expenditure or perform the labor required will subject the claim to relocation by any other party having the necessary qualifications, unless the original locator, his heirs, assigns, or legal representatives have resumed work thereon after such failure and before such relocation.

18. The expenditures required upon mining claims may be made from the surface or in running a tunnel for the development of such claims, the Act of February 11, 1875, providing that where a person or company has, or may, run a tunnel for the purpose of developing a lode or lodes owned by said person or company, the money so expended in said tunnel shall be taken and considered as expended on said lode or lodes, and such person or company shall not be required to perform work on the surface of said lode or lodes in order to hold the same.

19. The importance of attending to these details in the matter of location, labor, and expenditure will be the more readily perceived when it is understood that a failure to give the subject proper attention may invalidate the claim.

TUNNEL RIGHTS.

20. Section 2323 provides that where a tunnel is run for the development of a vein or lode, or for the discovery of mines, the owners of such tunnel shall have the right of possession of all veins or lodes within three thousand feet from the face of such tunnel on the line thereof, not previously known to exist, discovered in such tunnel, to the same extent as if discovered from the surface; and locations on the line of such tunnel of veins or lodes not appearing on the surface, made by other parties after the commencement of the tunnel, and while the same is being prosecuted with reasonable diligence, shall be invalid; but failure to prosecute the work on the tunnel for six months shall be considered as an abandonment of the right to all undiscovered veins or lodes on the line of said tunnel.

21. The effect of this is simply to give the proprietors of a mining tunnel run in good faith the possessory right to fifteen hundred feet of any blind lodes cut, discovered, or intersected by such tunnel, which were not previously known to exist, within three thousand feet from the face or point of commencement of such tunnel, and to prohibit other parties, after the commencement of the tunnel, from prospecting for and making locations of lodes on the *line thereof* and within said distance of three thousand feet, unless such lodes appear upon the surface or were previously known to exist.

22. The term "face," as used in said section, is construed and held to mean the first working-face formed in the tunnel, and to signify the point at which the tunnel actually enters cover; it being from this point that the three thousand feet are to be counted, upon which prospecting is prohibited as aforesaid.

23. To avail themselves of the benefits of this provision of law, the proprietors of a mining tunnel will be required, at the time they enter cover, as aforesaid, to give proper notice of their tunnel location by erecting a substantial post, board, or monument at the face or point of commencement thereof, upon which should be posted a good and sufficient notice, giving the names of the parties or company claiming the tunnel

right; the actual or proposed course or direction of the tunnel; the height and width thereof, and the course and distance from such face or point of commencement to some permanent well known objects in the vicinity by which to fix and determine the *locus* in manner heretofore set forth applicable to locations of veins or lodes, and at the time of posting such notice they shall, in order that miners or prospectors may be enabled to determine whether or not they are within the lines of the tunnel, establish the boundary lines thereof, by stakes or monuments placed along such lines at proper intervals, to the terminus of the three thousand feet from the face or point of commencement of the tunnel, and the lines so marked will define and govern as to the specific boundaries within which prospecting for lodes not previously known to exist is prohibited while work on the tunnel is being prosecuted with reasonable diligence.

24. At the time of posting notice and marking out the lines of the tunnel as aforesaid, a full and correct copy of such notice of location defining the tunnel claim must be filed for record with the mining Recorder of the district, to which notice must be attached the sworn statement or declaration of the owners, claimants, or projectors of such tunnel, setting forth the facts in the case; stating the amount expended by themselves and their predecessors in interest in prosecuting work thereon; the extent of the work performed, and that it is *bona fide* their intention to prosecute work on the tunnel so located and described with reasonable diligence for the development of a vein or lode, or for the discovery of mines, or both, as the case may be. This notice of location must be duly recorded, and, with the said sworn statement attached, kept on the Recorder's files for future reference.

25. By a compliance with the foregoing much needless difficulty will be avoided, and the way for the adjustment of legal rights acquired in virtue of said Section 2323 will be made much more easy and certain.

26. This office will take particular care that no improper advantage is taken of this provision of law by parties making or professing to make tunnel locations, ostensibly for the purposes named in the statute, but really for the purpose of monopolizing the lands lying in front of their tunnels to the detriment of the mining interests and to the exclusion of *bona fide* prospectors or miners, but will hold such tunnel claimants to a strict compliance with the terms of the statutes; and a *reasonable diligence* on their part in prosecuting the work is one of the essential conditions of their implied contract. Negligence or want of due diligence will be construed as working a forfeiture of their right to all undiscovered veins on the line of such tunnel.

MANNER OF PROCEEDING TO OBTAIN GOVERNMENT TITLE TO VEIN OR LODE CLAIMS.

27. By Section 2325 authority is given for granting titles for mines by patent from the Government to any person, association, or corporation having the necessary qualifications as to citizenship and holding the right of possession to a claim in compliance with law.

28. The claimant is required in the first place to have a correct survey of his claim made under authority of the Surveyor-General of the State or Territory in which the claim lies; such survey to show with accuracy the exterior surface boundaries of the claim, which boundaries are required to be distinctly marked by monuments on the ground. Four plats and one copy of the original field notes, in each case, will be prepared by the

Surveyor-General; one plat and the original field notes to be retained in the office of the Surveyor-General, one copy of the plat to be given to the claimant for posting upon the claim, one plat and a copy of the field notes to be given the claimant for filing with the proper Register, to be finally transmitted by that officer, with other papers in the case, to this office, and one plat to be sent by the Surveyor-General to the Register of the proper land district, to be retained on his files for future reference.

29. The claimant is then required to post a copy of the plat of such survey in a conspicuous place upon the claim, together with notice of his intention to apply for a patent therefor, which notice will give the date of posting, the name of the claimant, the name of the claim, mine, or lode; the mining district and county; whether the location is of record, and, if so, where the record may be found; the number of feet claimed along the vein and the presumed direction thereof; the number of feet claimed on the lode in each direction from the point of discovery, or other well defined place on the claim; the name or names of adjoining claimants on the same or other lodes; or, if none adjoin, the names of the nearest claims, etc.

30. After posting the said plat and notice upon the premises, the claimant will file with the proper Register and Receiver a copy of such plat, and the field notes of survey of the claim, accompanied by the affidavit of at least two credible witnesses, that such plat and notice are posted conspicuously upon the claim, giving the date and place of such posting; a copy of *the notice* so posted to be attached to and form a part of said affidavit.

31. Attached to the field notes so filed must be the sworn statement of the claimant that he has the possessory right to the premises therein described, in virtue of a compliance by himself (and by his grantors, if he claims by purchase) with the mining rules, regulations, and customs of the mining district, State, or Territory in which the claim lies, and with the mining laws of Congress; such sworn statement to narrate briefly, but as clearly as possible, the facts constituting such compliance, the origin of his possession, and the basis of his claim to a patent.

32. This affidavit should be supported by appropriate evidence from the mining Recorder's office as to his possessory right, as follows, viz.: Where he claims to be a locator, a full, true, and correct copy of such location should be furnished, as the same appears upon the mining records; such copy to be attested by the seal of the Recorder, or if he has no seal, then he should make oath to the same being correct, as shown by his records; where the applicant claims as a locator in company with others who have since conveyed their interests in the lode to him, a copy of the original record of location should be filed, together with an abstract of title from the proper Recorder, under seal or oath as aforesaid, tracing the co-locator's possessory rights in the claim to such applicant for patent; where the applicant claims only as a purchaser for valuable consideration, a copy of the location record must be filed, under seal or upon oath as aforesaid, with an abstract of title certified as above by the proper Recorder, tracing the right of possession by a continuous chain of conveyances from the original locators to the applicant, also certifying that no conveyances affecting the title to the claim in question appear of record in his office other than those set forth in the accompanying abstract.

33. In the event of the mining records in any case having been destroyed by fire or otherwise lost, affidavit of the fact should be made, and secondary evidence of possessory title will be received, which may consist of the affidavit of the claimant, supported by those of any other parties cognizant of the facts relative to his location, occupancy, possession, improvements, etc.; and in such case of lost records, any deeds, certificates of location or pur-

chase, or other evidence which may be in the claimant's possession, and tend to establish his claim, should be filed.

34. Upon the receipt of these papers the Register will, at the expense of the claimant (who must furnish the agreement of the publisher to hold applicant for patent alone responsible for charges of publication), publish a notice of such application for the period of sixty days, in a newspaper published nearest to the claim; and will post a copy of such notice in his office for the same period. In all cases sixty days must intervene between the first and the last insertion of the notice in such newspaper. When the notice is published in a weekly newspaper, ten consecutive insertions are necessary; when in a daily newspaper, the notice must appear in each issue for the required period.

35. The notices so published and posted must be as full and complete as possible, and embrace all the *data* given in the notice posted upon the claim.

36. Too much care cannot be exercised in the preparation of these notices, inasmuch as upon their accuracy and completeness will depend, in a great measure, the regularity and validity of the whole proceeding.

37. The claimant, either at the time of filing these papers with the Register, or at any time during the sixty days' publication, is required to file a certificate of the Surveyor-General that not less than five hundred dollars' worth of labor has been expended or improvements made upon the claim by the applicant or his grantors; that the plat filed by the claimant is correct; that the field notes of the survey, as filed, furnish such an accurate description of the claim as will, if incorporated into a patent, serve to fully identify the premises, and that such reference is made therein to natural objects or permanent monuments as will perpetuate and fix the *locus* thereof.

38. It will be the more convenient way to have this certificate indorsed by the Surveyor-General, both upon the plat and field notes of survey filed by the claimant as aforesaid.

39. After the sixty days' period of newspaper publication has expired the claimant will file his affidavit, showing that the plat and notice aforesaid remained conspicuously posted upon the claim sought to be patented during said sixty days' publication, giving the dates.

40. Upon the filing of this affidavit the Register will, if no adverse claim was filed in his office during the period of publication, permit the claimant to pay for the land according to the area given in the plat and field notes of survey aforesaid, at the rate of five dollars for each acre, and five dollars for each fractional part of an acre, the Receiver issuing the usual duplicate receipt therefor. The claimant will also make a sworn statement of all charges and fees paid by him for publication and surveys, together with all fees and money paid the Register and Receiver of the Land Office, after which the whole matter will be forwarded to the Commissioner of the General Land Office, and a patent issued thereon, if found regular.

41. In sending up the papers in the case the Register must not omit certifying to the fact that the notice was posted in his office for the full period of sixty days, such certificate to state distinctly when such posting was done, and how long continued.

42. The consecutive series of numbers of mineral entries must be continued, whether the same are of lode or placer claims.

43. The Surveyor-General must continue to designate all surveyed mineral claims as heretofore, by a progressive series of numbers, beginning with lot No. 37 in each township; the claim to be so designated at date

of filing the plat, field notes, etc., in addition to the local designation of the claim, it being required in all cases that the plat and field notes of the survey of a claim must, in addition to the reference to permanent objects in the neighborhood, describe the *locus* of the claim with reference to the lines of public surveys, by a line connecting a corner of the claim with the nearest public corner of the United States surveys, unless such claim be on unsurveyed lands, at a remote distance from such public corner, in which latter case the reference by course and distance to permanent objects in the neighborhood will be a sufficient designation by which to fix the *locus*, until the public surveys shall have been closed upon its boundaries.

ADVERSE CLAIMS.

44. Section 2326 provides for adverse claims, fixes the time within which they shall be filed to have legal effect, and prescribes the manner of their adjustment.

45. Said section requires that the adverse claim shall be filed during the period of publication of notice; that it must be on the oath of the adverse claimant; and that it must show the "*nature*," the "*boundaries*," and the "*extent*" of the adverse claim.

46. In order that this section of law may be properly carried into effect, the following is communicated for the information of all concerned:

47. An adverse mining claim must be filed with the Register of the same Land Office with whom the application for patent was filed, or in his absence, with the Receiver, and within the sixty days' period of newspaper publication of notice.

48. The adverse notice must be duly sworn to by the person or persons making the same, before an officer authorized to administer oaths within the land district, or before the Register or Receiver; it will fully set forth the nature and extent of the interference or conflict; whether the adverse party claims as a purchaser for valuable consideration, or as a locator; if the former, a certified copy of the original location, the original conveyance, a duly certified copy thereof, or an abstract of title from the office of the proper Recorder, should be furnished, or if the transaction was a mere verbal one, he will narrate the circumstances attending the purchase, the date thereof, and the amount paid, which facts should be supported by the affidavit of one or more witnesses, if any were present at the time, and if he claims as a locator, he must file a duly certified copy of the location from the office of the proper Recorder.

49. In order that the "*boundaries*" and "*extent*" of the claim may be shown, it will be incumbent upon the adverse claimant to file a plat, showing his entire claim, its relative situation or position with the one against which he claims, and the extent of the conflict. This plat must be made from an actual survey by a United States Deputy Surveyor, who will officially certify thereon to its correctness; and in addition there must be attached to such plat of survey a certificate or sworn statement by the Surveyor as to the approximate value of the labor performed or improvements made upon the claim by the adverse party or his predecessors in interest, and the plat must indicate the position of any shafts, tunnels, or other improvements, if any such exist, upon the claim of the party opposing the application, and by which party said improvements were made.

50. Upon the foregoing being filed within the sixty days, as aforesaid, the Register, or in his absence the Receiver, will give notice in writing to *both parties* to the contest, that such adverse claim has been filed, informing them that the party who filed the adverse claim will be required within thirty

days from the date of such filing, to commence proceedings in a Court of competent jurisdiction to determine the question of right of possession, and to prosecute the same with reasonable diligence to final judgment, and that should such adverse claimant fail to do so, his adverse claim will be considered waived, and the application for patent be allowed to proceed upon its merits.

51. When an adverse claim is filed as aforesaid, the Register or Receiver will indorse upon the same the precise date of filing, and preserve a record of the date of notifications issued thereon; and thereafter all proceedings on the application for patent will be suspended, with the exception of the completion of the publication, and posting of notices, and plat, and the filing of the necessary proof thereof, until the controversy shall have been adjudicated in Court, or the adverse claim waived or withdrawn.

52. The proceedings after rendition of judgment by the Court in such case are so clearly defined by the act itself as to render it unnecessary to enlarge thereon in this place.

53. The proceedings to obtain patents for claims usually called placers, including all forms of deposit, are similar to the proceedings prescribed for obtaining patents for vein or lode claims; but where said placer claim shall be upon surveyed lands, and conform to legal subdivisions, no further survey or plat will be required, and all placer mining claims located after May 10, 1872, shall conform as nearly as practicable with the United States system of public land surveys and the rectangular subdivisions of such surveys, and no such location shall include more than twenty acres for each individual claimant; but where placer claims cannot be conformed to legal subdivisions, survey and plat shall be made as on unsurveyed lands. But where such claims are located previous to the public surveys, and do not conform to legal subdivisions, survey, plat, and entry thereof may be made according to the boundaries thereof, provided the location is in all respects legal.

54. The proceedings for obtaining patents for veins or lodes having already been fully given, it will not be necessary to repeat them here; it being thought that careful attention thereto by applicants and the local officers will enable them to act understandingly in the matter and make such slight modifications in the notice, or otherwise, as may be necessary in view of the different nature of the two classes of claims, placer claims being fixed, however, at two dollars and fifty cents per acre, or fractional part of an acre.

55. By Section 2330, authority is given for the subdivision of forty-acre legal subdivisions into *ten-acre* lots, which is intended for the greater convenience of miners in segregating their claims both from one another and from intervening agricultural lands.

56. It is held, therefore, that under a proper construction of the law these ten-acre lots in mining districts should be considered and dealt with, to all intents and purposes, as legal subdivisions, and that an applicant having a legal claim which conforms to one or more of these ten-acre lots, either adjoining or cornering, may make entry thereof, after the usual proceedings, without further survey or plat.

57. In cases of this kind, however, the notice given of the application must be very specific and accurate in description, and as the forty-acre tracts may be subdivided into ten-acre lots, either in the form of squares of ten by ten chains, or of parallelograms five by twenty chains, so long as the lines are parallel and at right angles with the lines of the public surveys, it will be necessary that the notice and application state specifi-

cally what ten-acre lots are sought to be patented, in addition to the other *data* required in the notice.

58. Where the ten-acre subdivision is in the form of a square it may be described, for instance, as the "S. E. ¼ of the S. W. ¼ of N. W. ¼," or, if in the form of a parallelogram as aforesaid, it may be described as the "W. ½ of the W. ½ of the S. W. ¼ of the N. W. ¼ (or the N. ½ of the S. ½ of the N. E. ¼ of the S. E. ¼) of section ——, township ——, range ——," as the case may be; but, in addition to this description of the land, the notice must give all the other *data* that is required in a mineral application, by which parties may be put on inquiry as to the premises sought to be patented. The proof submitted with applications for claims of this kind must show clearly the character and the extent of the improvements upon the premises.

Inasmuch as the Surveyor-General has no duty to perform in connection with the entry of a placer claim of legal subdivisions, the proof of improvements must show their value to be not less than *five hundred dollars* and that they were made by the applicant for patent or his grantors.

59. Applicants for patent to a placer claim, who are also in possession of a known vein or lode included therein, must state in their application that the placer includes such vein or lode. The published and posted notices must also include such statement; and the vein or lode must be surveyed and marked upon the plat; the field notes and plat giving the area of the lode claim or claims and the area of the placer separately. If veins or lodes lying within a placer location are owned by other parties, the fact should be distinctly stated in the application for patent, and in all the notices. It should be remembered that an application which omits to include an application for a known vein or lode therein, must be construed as a conclusive declaration that the applicant has no right of possession to the vein or lode. Where there is no known lode or vein, the fact must appear by the affidavit of claimant and one or more witnesses.

60. When an adverse claim is filed to a placer application, the proceedings are the same as in the case of vein or lode claims, already described.

QUANTITY OF PLACER GROUND SUBJECT TO LOCATION.

61. By Section 2330 it is declared that no location of a placer claim, made after July 9, 1870, shall exceed one hundred and sixty acres for any one person or association of persons, which location shall conform to the United States surveys.

62. Section 2331 provides that all placer mining claims located after May 10, 1872, shall conform as nearly as practicable with the United States system of public surveys and the subdivisions of such surveys, and no such locations shall include more than twenty acres for each individual claimant.

63. The foregoing provisions of law are construed to mean that after the ninth day of July, 1870, no location of a placer claim can be made to exceed one hundred and sixty acres, whatever may be the number of locators associated together, or whatever the local regulations of the district may allow; and that from and after May 10, 1872, no location made by an individual can exceed twenty acres, and no location made by an association of individuals can exceed one hundred and sixty acres; which location of one hundred and sixty acres cannot be made by a less number than eight *bona fide* locators; and no local laws or mining regulations can restrict a placer location to less than twenty acres, although the locator is not compelled to take so much.

64. The regulations hereinbefore given as to the manner of marking loca-

tions on the ground, and placing the same on record, must be observed in the case of placer locations, so far as the same are applicable; the law requiring, however, that where placer claims are upon *surveyed* public lands, the locations must hereafter be made to conform to legal subdivisions thereof as near as practicable.

65. With regard to the proofs necessary to establish the possessory right to a placer claim, Section 2332 provides that "where such person or association, they and their grantors, have held and worked their claims for a period equal to the time prescribed by the statute of limitations for mining claims of the State or Territory where the same may be situated, evidence of such possession and working of the claims for such period shall be sufficient to establish a right to a patent thereto under this chapter, in the absence of any adverse claim."

66. This provision of law will greatly lessen the burden of proof, more especially in the case of old claims located many years since, the records of which, in many cases, have been destroyed by fire, or lost in other ways during the lapse of time, but concerning the possessory right to which all controversy or litigation has long been settled.

67. When an applicant desires to make his proof of possessory right in accordance with this provision of law, you will not require him to produce evidence of location, copies of conveyances, or abstracts of title, as in other cases, but will require him to furnish a duly certified copy of the statute of limitations of mining claims for the State or Territory, together with his sworn statement giving a clear and succinct narration of the facts as to the origin of his title, and likewise as to the continuation of his possession of the mining ground covered by his application; the area thereof, the nature and extent of the mining that has been done thereon; whether there has been any opposition to his possession, or litigation with regard to his claim, and if so, when the same ceased; whether such cessation was caused by compromise or by judicial decree; and any additional facts within the claimant's knowledge having a direct bearing upon his possession and *bona fides* which he may desire to submit in support of his claim.

68. There should likewise be filed a certificate, under seal of the Court having jurisdiction of mining cases within the judicial district embracing the claim, that no suit or action of any character whatever involving the right of possession to any portion of the claim applied for is pending, and that there has been no litigation before said Court affecting the title to said claim, or any part thereof, for a period equal to the time fixed by the statute of limitations for mining claims in the State or Territory as aforesaid, other than that which has been finally decided in favor of the claimant.

69. The claimant should support his narrative of facts relative to his possession, occupancy, and improvements, by corroborative testimony of any disinterested person or persons of credibility who may be cognizant of the facts in the case, and are capable of testifying understandingly in the premises.

70. It will be to the advantage of claimants to make their proofs as full and complete as practicable.

MILL-SITES.

71. Section 2337 provides that "where non-mineral land not contiguous to the vein or lode is used or occupied by the proprietor of such vein or lode for mining or milling purposes, such non-adjacent surface ground may be embraced and included in an application for a patent for such vein or lode, and the same may be patented therewith, subject to the same pre-

liminary requirements as to survey and notice as are applicable to veins or lodes; but no location hereafter made of such non-adjacent land shall exceed five acres, and payment for the same must be made at the same rate as fixed by this chapter for the superficies of the lode. The owner of a quartz mill or reduction works, not owning a mine in connection therewith, may also receive a patent for his mill-site, as provided in this section."

72. To avail themselves of this provision of law, parties holding the possessory right to a vein or lode, and to a piece of non-mineral land not contiguous thereto, for mining or milling purposes, not exceeding the quantity allowed for such purpose by Section 2337, United States Revised Statutes, or prior laws under which the land was appropriated, the proprietors of such vein or lode may file in the proper Land Office their application for a patent, under oath, in manner already set forth herein, which application, together with the plat and field notes, may include, embrace, and describe, in addition to the vein or lode, such non-contiguous mill-site, and after due proceedings as to notice, etc., a patent will be issued conveying the same as one claim.

73. In making the survey in a case of this kind, the lode-claim should be described in the plat and field-notes as "Lot No. 37, A," and the mill-site as "Lot No. 37, B," or whatever may be its appropriate numerical designation; the course and distance from a corner of the mill-site to a corner of the lode-claim to be invariably given in such plat and field notes, and a copy of the plat and notice of application for patent must be conspicuously posted upon the mill-site as well as upon the vein or lode, for the statutory period of sixty days. In making the entry no separate receipt or certificate need be issued for the mill-site, but the whole area of both lode and mill-site will be embraced in one entry, the price being five dollars for each acre and fractional part of an acre embraced by such lode and mill-site claim.

74. In case the owner of a quartz mill or reduction works is not the owner or claimant of a vein or lode, the law permits him to make application therefor in the same manner prescribed herein for mining claims, and after due notice and proceedings, in the absence of a valid adverse filing, to enter and receive a patent for his mill-site at said price per acre.

75. In every case there must be satisfactory proof that the land claimed as a mill-site is not mineral in character, which proof may, where the matter is unquestioned, consist of the sworn statement of the claimant, supported by that of one or more disinterested persons capable from acquaintance with the land to testify understandingly.

76. The law expressly limits mill-site locations made from and after its passage to *five acres*.

77. The Registers and Receivers will preserve an unbroken consecutive series of numbers for all mineral entries.

PROOF OF CITIZENSHIP OF MINING CLAIMANTS.

78. The proof necessary to establish the citizenship of applicants for mining patents must be made in the following manner: In case of an incorporated company, a certified copy of their charter or certificate of incorporation must be filed. In case of an association of persons unincorporated, the affidavit of their duly authorized agent, made upon his own knowledge, or upon information and belief, setting forth the residence of each person forming such association, must be submitted. This affidavit must be accompanied by a power of attorney from the parties forming such associ-

ation, authorizing the person who makes the affidavit of citizenship to act for them in the matter of their application for patent.

79. In case of an individual or an association of individuals who do not appear by their duly authorized agent, you will require the affidavit of each applicant, showing whether he is a native or naturalized citizen, when and where born, and his residence.

80. In case an applicant has declared his intention to become a citizen, or has been naturalized, his affidavit must show the date, place, and the Court before which he declared his intention, or from which his certificate of citizenship issued, and present residence.

81. The affidavit of the claimant as to his citizenship may be taken before the Register or Receiver, or any other officer authorized to administer oaths within the land district. If citizenship is established by the testimony of disinterested persons, such testimony may be taken at any place before any person authorized to administer oaths, and whose official character is duly verified.

APPOINTMENT OF DEPUTY SURVEYORS OF MINING CLAIMS—CHARGES FOR SURVEYS AND PUBLICATIONS—FEES OF REGISTERS AND RECEIVERS, ETC.

82. Section 2334 provides for the appointment of surveyors of mineral claims, authorizes the Commissioner of the General Land Office to establish the rates to be charged for surveys and for newspaper publications, prescribes the fees allowed to the local officers for receiving and acting upon applications for mining patents and for adverse claims thereto, etc.

Under this authority of law the following rates have been established as the maximum charges for newspaper publications in mining cases:

a. Where a daily newspaper is designated the charge shall not exceed seven dollars for each ten lines of space occupied, and where a weekly newspaper is designated as the medium of publication, five dollars for the same space will be allowed. Such charge shall be accepted as full payment for publication in each issue of the newspaper for the entire period required by law.

It is expected that these notices shall not be so abbreviated as to curtail the description essential to a perfect notice, and the said rates established upon the understanding that they are to be in the usual body-type used for advertisements.

b. For the publication of citations in contests or hearings involving the character of lands, the charges shall not exceed eight dollars for five publications in weekly newspapers, or ten dollars for publications in daily newspapers for thirty days.

83. The Surveyors-General of the several districts will, in pursuance of said law, appoint in each land district as many *competent* deputies for the survey of mining claims as may seek such appointment; it being distinctly understood that all expenses of these notices and surveys are to be borne by the mining claimants and not by the United States; the system of making *deposits* for mineral surveys, as required by previous instructions, being hereby revoked as regards *field work;* the claimant having the option of employing *any* deputy surveyor within such district to do his work in the field.

84. With regard to the *platting* of the claim and other *office work* in the Surveyor-General's Office, that officer will make an estimate of the cost thereof, which amount the claimant will deposit with any Assistant United States Treasurer, or designated depository, in favor of the United States Treasurer, to be passed to the credit of the fund created by "individual

depositors for surveys of the public lands," and file with the Surveyor-General duplicate certificate of such deposit in the usual manner.

85. The Surveyors-General will endeavor to appoint mineral deputy surveyors, so that one or more may be located in each mining district for the greater convenience of miners.

86. The usual oaths will be required of these deputies and their assistants as to the correctness of each survey executed by them.

The duty of the deputy mineral surveyor ceases when he has executed the survey and returned the field notes and preliminary plat thereof with his report to the Surveyors-General. He will not be allowed to prepare for the mining claimant the papers in support of an application for patent, or otherwise perform the duties of an attorney before the Land Office in connection with a mining claim.

The Surveyor-General and local land officers are expected to report any infringement of this regulation to this office.

87. The law requires that each applicant shall file with the Register and Receiver a sworn statement of all charges and fees paid by him for publication of notice and for survey; together with all fees and money paid the Register and Receiver, which sworn statement is required to be transmitted to this office, for the information of the Commissioner.

88. Should it appear that excessive or exorbitant charges have been made by any surveyor, or any publisher, prompt action will be taken with the view of correcting the abuse.

89. The fees payable to the Register and Receiver for filing and acting upon applications for mineral land patents are five dollars to each officer, to be paid by the applicant for patent at the time of filing, and the like sum of five dollars is payable to each officer by an adverse claimant at the time of filing his adverse claim.

90. All fees or charges under this law may be paid in United States currency.

91. The Register and Receiver will, at the close of each month, forward to this office an abstract of mining applications filed, and a register of receipts, accompanied with an abstract of mineral lands sold, and an abstract of adverse claims filed.

92. The fees and purchase money received by Registers and Receivers must be placed to the credit of the United States in the Receiver's monthly and quarterly account, charging up in the disbursing account the sums to which the Register and Receiver may be, respectively, entitled as fees and commissions, with limitations in regard to the legal maximum.

HEARINGS TO ESTABLISH THE CHARACTER OF LANDS.

93. In every case where it becomes necessary, under the law and existing instructions of this office, that a hearing be held and testimony taken for the purpose of ascertaining the mineral or agricultural character of land, the local officers are directed to cause the evidence to be taken before a duly qualified officer, whose office is located nearest the land in dispute, the distance to be computed by ordinary routes of travel.

Whenever the local office comes within this rule, the hearing will be held before the Register and Receiver.

It is intended to cause these hearings to be held, as far as practicable, in such manner as to afford the least inconvenience to persons interested. Should it appear, therefore, by written stipulation of all the parties, that this purpose will best be subserved by the designation of any particular officer authorized to administer oaths within the land district in which the

land in controversy is situated, the instructions herein may be departed from in accordance with such stipulation. Such deviation may also be allowed where the officer who would, otherwise, be designated is an interested party, or where, for other good reasons, his selection would be improper.

When the evidence is taken before an officer other than the Register and Receiver, the record should be sealed up, the title of the case indorsed on the envelope, and the whole returned by mail or express to the Register and Receiver.

On the twenty-seventh April, 1880, in accordance with the directions of the Secretary of the Interior, this office revoked the withdrawals theretofore made, upon general information, that vast tracts of public land were mineral in character, and instructed the local officers, in the absence of a specific allegation of the mineral character of land, to allow applications for agricultural entry thereof, upon due proof.

Hereafter the only tracts of public lands that will be withheld from entry as agricultural land on account of its mineral character, will be such as are returned by the Surveyor-General as mineral; and even the presumption which is supported by such return may be overcome by testimony taken at a regular hearing.

94. Hearings to determine the character of land, as practically distinguished, are of two kinds:

First—Where lands which are sought to be entered and patented as agricultural are alleged by affidavit to be mineral, or when sought as mineral their non-mineral character is alleged.

The proceedings relative to this class are in the nature of a contest between two or more known parties, and the testimony may be taken on personal notice of at least ten days, duly served on all parties, or, if they cannot be found, then by publication for thirty days in a newspaper of general circulation, to be designated by the Register of the Land Office as published nearest to the land in controversy. If publication is made in a weekly newspaper, the notice must be inserted in five consecutive weekly issues thereof.

Second—When lands are returned as mineral by the Surveyor-General.

When such lands are sought to be entered as agricultural, notice must be given by publication for thirty days, as aforesaid.

95. All notices must describe the land, give the name and address of the claimant, the character of his claim, and the time, place, and purpose of the hearing.

Proof of service of notice, when personal, must consist of either acknowledgment of service indorsed on the citation (which is always desirable), or the affidavit of the party serving the same, giving date, place, and manner of service, indorsed as aforesaid.

Proof of publication must be the affidavit of the publisher of the newspaper, stating the period of publication, giving dates, stating whether in a daily or weekly issue, and a copy of the notice so published must be attached to and form a part of the affidavit.

Proof of posting on the claim must be made by the affidavits of two or more persons who state when and where the notice was posted; that it remained so posted during the prescribed period, giving dates, and a copy of the notice so posted must be attached to and made a part of the affidavits.

Proof of notice is indispensable to the regularity of proceedings and must accompany the record in every case.

The expense of notice must in every case be paid by the parties thereto.

96. At the hearing there must be filed the affidavit of the publisher of

the paper that said notice was published for the required time, stating when and for how long such publication was made, a printed copy thereof to be attached and made a part of the affidavit.

97. At the hearing the claimants and witnesses will be thoroughly examined with regard to the character of the land; whether the same has been thoroughly prospected; whether or not there exists within the tract or tracts claimed any lode or vein of quartz or other rock in place, bearing gold, silver, cinnabar, lead, tin, or copper, or other valuable deposit which has ever been claimed, located, recorded, or worked; whether such work is entirely abandoned, or whether occasionally resumed; if such lode does exist, by whom claimed, under what designation, and in which subdivision of the land it lies; whether any placer mine or mines exist upon the land; if so, what is the character thereof—whether of the shallow surface description, or of the deep cement, blue lead, or gravel deposits; to what extent mining is carried on when water can be obtained, and what the facilities are for obtaining water for mining purposes; upon what particular ten-acre subdivisions mining has been done, and at what time the land was abandoned for mining purposes, if abandoned at all.

98. The testimony should also show the agricultural capacities of the land, what kind of crops are raised thereon, and the value thereof; the number of acres actually cultivated for crops of cereals or vegetables, and within which particular ten-acre subdivision such crops are raised; also which of these subdivisions embrace his improvements, giving in detail the extent and value of his improvements, such as house, barn, vineyard, orchard, fencing, etc.

99. It is thought that bona fide settlers upon lands really agricultural will be able to show, by a clear, logical, and succinct chain of evidence, that their claims are founded upon law and justice; while parties who have made little or no permanent agricultural improvements, and who only seek title for speculative purposes, on account of the mineral deposits known to themselves to be contained in the land, will be defeated in their intentions.

100. The testimony should be as full and complete as possible; and, in addition to the leading points indicated above, everything of importance bearing upon the question of the character of the land should be elicited at the hearing.

101. Where the testimony is taken before an officer who does not use a seal, other than the Register and Receiver, the official character of such officer must be attested by a clerk of a Court of record, and the testimony transmitted to the Register and Receiver, who will thereupon examine and forward the same to this office, with their joint opinion as to the character of the land as shown by the testimony.

102. When the case comes before this office, such an award of the land will be made as the law and the facts may justify; and in cases where a survey is necessary to set apart the mineral from the agricultural land in any forty-acre tract, the necessary instructions will be issued to enable the agricultural claimant, *at his own expense*, to have the work done, at his option, either by United States deputy, county, or other local surveyor; the survey in such case may be executed in such manner as will segregate the portion of land actually containing the mine, and used as surface-ground for the convenient working thereof, from the remainder of the tract, which remainder will be patented to the agriculturist to whom the same may have been awarded, subject, however, to the condition that the land may be entered upon by the proprietor of any vein or lode for which a

patent has been issued by the United States for the purpose of extracting and removing the ore from the same, where found to penetrate or intersect the land so patented as agricultural, as stipulated by the mining Act.

103. Such survey when executed must be properly sworn to by the Surveyor, either before a Notary Public, officer of a Court of record, or before the Register or Receiver, the deponent's character and credibility to be properly certified to by the officer administering the oath.

104. Upon the filing of the plat and field notes of such survey, duly sworn to as aforesaid, you will transmit the same to the Surveyor-General for his verification and approval; who, if he finds the work correctly performed, will properly mark out the same upon the original township plat in his office, and furnish authenticated copies of such plat and description both to the proper local Land Office and to this office, to be affixed to the duplicate and triplicate township plats respectively.

105. In cases where a portion of a forty-acre tract is awarded to an agricultural claimant, and he causes the segregation thereof from the mineral portion, as aforesaid, such agricultural portion will not be given a numerical designation, as in the case of surveyed mineral claims, but will simply be described as the "Fractional —— quarter of the —— quarter of section ——, in township ——, of range ——, —— meridian, containing —— acres, the same being exclusive of the land adjudged to be mineral in said forty-acre tract."

106. The Surveyor must correctly compute the area of such agricultural portion, which computation will be verified by the Surveyor-General.

107. After the authenticated plat and field notes of the survey have been received from the Surveyor-General, this office will issue the necessary order for the entry of the land, and in issuing the Receiver's receipt and Register's patent certificate you will invariably be governed by the description of the land given in the order from this office.

108. The fees for taking testimony and reducing the same to writing in these cases will have to be defrayed by the parties in interest. Where such testimony is taken before any other officer than the Register and Receiver, the Register and Receiver will be entitled to no fees.

109. If, upon a review of the testimony at this office, a ten-acre tract should be found to be properly mineral in character, that fact will be no bar to the execution of the settler's legal right to the remaining *non-mineral* portion of his claim, if contiguous.

110. No fear need be entertained that miners will be permitted to make entries of tracts ostensibly as mining claims, which are not mineral, simply for the purpose of obtaining possession and defrauding settlers out of their valuable agricultural improvements, it being almost an impossibility for such a fraud to be consummated under the laws and regulations applicable to obtaining patents for mining claims.

111. The fact that a certain tract of land is decided upon testimony to be mineral in character is by no means equivalent to an award of the land to a miner. A miner is compelled by law to give sixty days' publication of notice, and posting of diagrams and notices, as a preliminary step; and then, before he can enter the land, he must show that the land yields mineral; that he is entitled to the possessory right thereto in virtue of compliance with local customs or rules of miners, or by virtue of the statute of limitations; that he or his grantors have expended, in actual labor and improvements, an amount of not less than five hundred dollars thereon, and that the claim is one in regard to which there is no controversy or opposing claim. After all these proofs are met he is entitled to

have a survey made, at his own cost, where a survey is required, after which he can enter and pay for the land embraced by his claim.

112. Blank forms for proofs in mineral cases are not furnished by the General Land Office.

Respectfully,

N. C. McFARLAND, Commissioner.

DEPARTMENT OF INTERIOR, October 31, 1881.

Approved:

S. J. KIRKWOOD, Secretary.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., April 27, 1880.

Registers and Receivers, U. S. District Land Offices:

GENTLEMEN: Your attention is directed to the following copy of a letter from the Hon. Secretary of the Interior:

DEPARTMENT OF THE INTERIOR, WASHINGTON, April 22, 1880.

SIR: I have received your letter of the sixteenth instant, calling my attention to the withdrawals heretofore made of mineral lands under the direction of my predecessor, Hon. C. Delano, and setting forth at length the difficulties which arise in the adjustment of homestead and preëmption claims on account of said withdrawals, and recommending in view of such difficulties that the "present policy and practice of throwing the burden of proof upon agricultural claimants be reversed; that the applicant for such entry be required to make the non-mineral affidavit required as aforesaid, and that this be deemed sufficient in absence of the alleged mineral character of his claim; that if a party does allege in proper form that the land is valuable for minerals, he should be required to affirmatively prove the fact, instead of in every case, with or without such allegation, requiring every settler to prove an expensive negative."

You further recommend "that the withdrawals heretofore made as aforesaid be revoked, in order to remove the restriction upon *bona fide* agricultural settlements, and to place such lands in a condition where they can be occupied, purchased, and developed."

I have carefully considered the recommendations made by you for the reasons stated and have to say that they meet my approval.

You are therefore instructed to so modify the instructions of your office as to conform to said recommendations, and you are also instructed to revoke the orders of withdrawals mentioned by you, in order that the restrictions thereby made upon agricultural settlements of the lands may be removed.

Very respectfully,

C. SCHURZ, Secretary.

THE COMMISSIONER OF THE GENERAL LAND OFFICE.

The recommendations to the Hon. Secretary, upon which his said approval was based, are, in brief and in substance, that immense tracts of land are now, and, for several years last past, have been, officially designated as mineral lands; that as a matter of fact but an exceedingly small part of this entire area is valuable for minerals, but is good agricultural land; that these withdrawn lands are subject to entry under the homestead, preemption, and other laws providing for the sale of agricultural lands only after a hearing in every case wherein the burden of proof lies upon the agricultural applicant to establish that the tract claimed is non-mineral; that it is thus rendered exceedingly easy to cause such applicant great expense, delay, and vexation; that the expense, embarrassment, and delay actually incident to the course hitherto pursued operate to discourage and prevent settlements on such lands; that the timber on these lands is being largely taken on the claim that they are mineral lands; and that the vast tracts so designated, and which are capable of supporting many thousands of settlers, adding largely to the productions of the country and contributing to its better progress, are not only for the most part practically reserved

from sale under any law, but being so secluded it becomes easy for a party to fraudulently enter as agricultural a tract which he may discover to be valuable for minerals than for a *bona fide* settler to secure patent for agricultural land. All of such withdrawals heretofore made of lands in your district are hereby revoked; and when any party applies to enter any tract under any of the laws relating to agricultural lands, he will be required to make the usual non-mineral affidavit, which, in the absence of any allegation that the land is mineral, will be deemed sufficient. Should affidavits be filed with you properly alleging any tract sought to be entered as aforesaid to be mineral, you will, after due notice, hold a hearing to determine the facts. In such cases the burden of proof will rest upon the party who alleges the land to be valuable for minerals, and he must affirmatively prove his allegations.

It is expected that you will exercise all possible prudence and care in respect to this matter, and endeavor to carefully and conscientiously maintain and advance the purpose of the department and this office, to wit: to enable the public lands which are in fact agricultural to be occupied and purchased without oppressive conditions, and to prevent lands which are in fact valuable for minerals from being taken, except under the special laws applicable thereto.

Very respectfully,

J. A. WILLIAMSON, Commissioner.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFCE,
WASHINGTON, D. C., September 23, 1880.

Registers and Receivers, United States District Land Offices:

GENTLEMEN: Hereafter, in case of application being made in your office to enter or select, as agricultural land under any Act of Congress other than the preëmption or homestead Acts, lands returned as mineral by the Surveyor-General, you will require the applicant, at date of final proof, location, or selection, to publish for thirty days a notice describing the land applied for, and giving time and place when such proof will be submitted or selection tendered. You will also post in your office a copy of the notice for the same period. Proof of publication will consist of the affidavit of the publisher of the newspaper in which the notice was published, and you will furnish your own certificate as to posting in your office.

The revocation of the withdrawals of lands as mineral by circular of April 27, 1880, was made not only because said withdrawals had, in many instances, worked great hardship to settlers, but because it is required by law that homestead and preëmption claimants shall publish notices of their intention to make final proof on their entries, and this was thought to afford sufficient protection to all parties; but in case of entries under other laws there is no such notice required. This procedure will apply to cases of application to enter under the town site, desert land, and timber culture laws; applications to select lands under grants to States, railroad and wagon-road companies; and the location of the various classes of scrip upon lands which have been returned by the Surveyor-General as mineral in character.

Where, after such publication of notice has been regularly made, no affidavits alleging the mineral character of the land have been filed with you, you will allow the entry, selection, or location upon the filing of a

proper non-mineral affidavit. If such mineral affidavits shall have been filed, you will proceed with a hearing, as directed by the circular of April 27, 1880.

Acknowledge receipt hereof.

Very respectfully,

J. A. WILLIAMSON, Commissioner.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., May 9, 1882.

To Registers and Receivers, United States District Land Offices:

GENTLEMEN: Your attention is directed to the provisions of the following Act of Congress, approved April 26, 1882:

An Act to amend section twenty-three hundred and twenty-six of the Revised Statutes, in regard to mineral lands, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That the adverse claim required by section twenty-three hundred and twenty-six of the Revised Statutes may be verified by the oath of any duly authorized agent or attorney in fact of the adverse claimant cognizant of the facts stated; and the adverse claimant, if residing or at the time being beyond the limits of the district wherein the claim is situated, may make oath to the adverse claim before the Clerk of any Court of record of the United States or the State or Territory where the adverse claimant may then be, or before any Notary Public of such State or Territory.

SEC. 2. That applicants for mineral patents, if residing beyond the limits of the district wherein the claim is situated, may make any oath or affidavit required for proof of citizenship before the Clerk of any Court of record, or before any Notary Public of any State or Terrritory.

1. It will be observed that the Act is not retroactive, and hence cannot affect proceedings had prior to its approval; where citizenship, however, has not been proven, it may be established as provided by section two of this Act.

2. Where an agent or attorney in fact verifies the adverse claim, he must distinctly swear that he is such agent or attorney, and accompany his affidavit by proof thereof.

3. The agent or attorney in fact must make the affidavit in verification of the adverse claim within the land district where the claim is situated.

Very respectfully,

N. C. McFARLAND, Commissioner.

Department of Interior, May 26, 1882.
Approved:

H. M. TELLER, Secretary.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., September 22, 1882.

To Registers and Receivers, and Surveyors-General:

GENTLEMEN: The following regulations are promulgated as amendatory of circular of October 31, 1881, entitled "United States Mining Laws and Regulations Thereunder," and have special reference to applications for patents to placer claims. They are to be considered in connection with paragraphs fifty-three to sixty of regulations contained in said circular:

1. The first care in recognizing an application for patent upon a placer

claim must be exercised in determining the exact classification of the lands. To this end the clearest evidence of which the case is capable should be presented. If the claim be all placer ground, that fact must be stated in the application, and corroborated by accompanying proofs. If of mixed placers and lodes it should be so set out, with a description of all known lodes situated within the boundaries of the claim. A specific declaration, such as is required by Section 2333, Revised Statutes, must be furnished as to each lode intended to be claimed. All other known lodes are, by the silence of the applicant, excluded by law from all claim by him, of whatsoever nature, possessory or otherwise.

2. Section 2395, Revised Statutes (subdivision 7), requires the Surveyor to "note in his field books, the true situation of all mines, salt licks, salt springs, and mill seats which come to his knowledge;" also, all water-courses over which the lines he runs may pass." It further requires him to "note the quality of the lands." These descriptive notes are required by subdivision 8 to be incorporated in the plat by the Surveyor-General.

3. If these duties have been performed, the surveys will furnish a reasonable guide to the district officers, and to claimants in prosecuting their applications. But experience has shown that great neglect has resulted from inattention to the law in this respect, and the regular plats are of very little value in the matter. It will, therefore, be required in the future that Deputy Surveyors shall, at the expense of the parties, make full examination of all placer claims, and duly note the facts as specified in the law, stating the quality and composition of the soil, the kind and amount of timber and other vegetation, the locus and size of streams, and such other matters as may appear upon the surface of the claims. This examination should include the character and extent of all surface and underground workings, whether placer or lode, for mining purposes.

4. In addition to these data, which the law requires to be shown in all cases, the deputy should report with reference to the proximity of centers of trade or residence; also of well known systems of lode deposit or of individual lodes. He should also report as to the use or adaptability of the claim for placer mining; whether water has been brought upon it in sufficient quantity to mine the same, or whether it can be procured for that purpose; and finally, what works or expenditures have been made by the claimant or his grantors for the development of the claim, and their situation and location with respect to the same as applied for.

5. This examination should be reported by the deputy under oath to the Surveyor-General, and duly corroborated; and a copy of the same should be furnished with the application for patent to the claim, constituting a part thereof, and included in the oath of the applicant.

6. In case of a proposed claim for lands not yet surveyed, the foregoing regulations will govern the application for survey.

7. In controversies hereafter to be determined respecting the mineral value of lands, their value for all purposes, whether agricultural or municipal, or as seats for towns, will be considered, without reference to the decisions heretofore made in particular cases. No decision finally executed, however, will be reconsidered under this modification.

8. No application by an association of persons for patent to a placer claim will be allowed to embrace more than one hundred and sixty acres, nor will any application be entertained that embraces more than one location.

9. Applications awaiting entry, whether published or not, must be made to conform to these regulations, both with respect to amount of ground and examination as to the character of the land. Entries already made

will be suspended for examination by the Commissioner, and such additional proofs as may be deemed necessary in each case will be demanded.

Very respectfully,

N. C. McFARLAND, Commissioner.

Department of the Interior, September 23, 1882.
Approved:

H. M. TELLER, Secretary.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFCE,
WASHINGTON, D. C., December 9, 1882.

To Registers and Receivers, and Surveyors-General:

GENTLEMEN: By direction, contained in letter dated the seventh instant, from the honorable Secretary of the Interior, paragraph number eight, of the preceding circular of September 22, 1882, relating to placer mining claims, has been amended so as to read as follows:

8. No application by an association of persons for patent to a placer claim will be allowed to embrace more than one hundred and sixty acres; and not less than five hundred dollars' worth of work must be shown to have been expended upon or for the benefit of each separate location embraced in such application. If an individual becomes the purchaser and possessor of several separate claims of twenty acres each or less, he may be permitted to include in his application for patent any number of such claims contiguous to each other, not exceeding in the aggregate one hundred and sixty acres; but upon or for the benefit of each original claim or location so embraced, he or his grantors must have expended the sum of five hundred dollars in improvements.

You are instructed to observe this modification of my said circular of September 22, 1882.

Very respectfully,

N. C. McFARLAND, Commissioner.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., November 16, 1882.

To United States Surveyors-General:

GENTLEMEN: The regulations of this office require that the plats and field notes of surveys of mining claims shall disclose all conflicts between such surveys and prior surveys, giving the areas of conflicts.

The rule has not been properly observed in all cases. Your attention is invited to the following particulars which should be observed in the survey of every mining claim:

1. The exterior boundaries of the claim should be represented on the plat of survey and in the field notes.

2. The intersection of the lines of the survey with the lines of conflicting prior surveys should be noted in the field notes and represented upon the plat.

3. Conflicts with unsurveyed claims, where the applicant for survey does not claim the area in conflict, should be shown by actual survey.

4. The total area of the claim embraced by the exterior boundaries should be stated, and also the area in conflict with each intersecting survey, substantially as follows:

Total area of claim	10.50 acres.
Area in conflict with Survey No. 302	1.56 acres.
Area in conflict with Survey No. 948	2.33 acres.
Area in conflict with Mountain Maid lode mining claim, unsurveyed	1.48 acres.

In a number of instances that have come to the attention of this office the total area in conflict has been given, but not the area in conflict with *each* intersecting claim. The portion of the plat not in conflict has been colored, and the remainder left uncolored. The language of the field notes has been such as to convey the idea that the conflicting areas were excluded from the claim, whereas such was not the intention. It does not follow that because mining surveys are required to exhibit all conflicts with prior surveys the areas of conflict are to be excluded. The field notes and plat are made a part of the application for patent, and care should be taken that the description does not inadvertently exclude portions intended to be retained. It is better that the application for patent should state the portions to be excluded in express terms. A survey executed as in the example given will enable the applicant for patent to exclude such conflicts as may seem desirable. For instance, the conflict with Survey No. 302, and with the Mountain Maid lode claim, might be excluded, and that with Survey No. 948 included.

Your attention is also invited to another matter. The practice of coloring portions of surveys, leaving other portions uncolored, is open to the same objections that have been stated concerning the field notes. In the future no coloring will be used.

Very respectfully,

N. C. McFARLAND, Commissioner.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., June 8, 1883.

To Registers and Receivers and Surveyors-General:

GENTLEMEN: The following additional regulations are promulgated as amendatory of circular of October 31, 1881, entitled "United States Mining Laws and Regulations Thereunder," which, except as herein modified, will remain in full force:

1. No application will be received, or entry allowed, which embraces more than one lode location.

2. A party who is not an applicant for patent under Section 2325, Revised Statutes, or the assignee of such applicant, is not entitled to make entry under said section, and in no case will the name of such party be inserted in the certificate of entry. This regulation has no reference to proceedings under Section 2326.

3. Any party applying to make entry as *trustee* must disclose fully the nature of the trust, and the name of the *cestui que trust;* and such trustee, as well as the beneficiaries, must furnish satisfactory proof of citizenship; and the names of beneficiaries, as well as that of the trustee, must be inserted in the final certificate of entry.

4. Where an adverse claim has been filed and suit thereon commenced within the statutory period, and final judgment determining the right of possession rendered in favor of the applicant, it will not be sufficient for him to file with the Register a certificate of the Clerk of the Court setting forth the facts as to such judgment, but he must, before he is allowed to

make entry, file a certified copy of the judgment, together with the other evidence required by Section 2326, Revised Statutes.

5. Where such suit has been dismissed, a certificate of the Clerk of the Court to that effect, or a certified copy of the order of dismissal, will be sufficient.

6. In no case will a relinquishment of the ground in controversy, or other proof, filed with the Register or Receiver, be accepted in lieu of the evidence required in paragraphs 4 and 5.

7. Where an adverse claim has been filed, but no suit commenced against the applicant for patent within the statutory period, a certificate to that effect, by the Clerk of the State Court having jurisdiction in the case, and also by the Clerk of the Circuit Court of the United States for the district in which the claim is situated, will be required.

8. Possessory title to a lode claim held and worked for a period equal to the time prescribed by the statute of limitations for mining claims of the State or Territory where the same may be situated, may, in the absence of any adverse claim, be established in the same manner as now allowed in placer claims, and indicated generally in paragraphs 67, 68, and 69, of the circular hereby amended.

9. No entry will be allowed until the Register has satisfied himself, by a careful examination, that proper proofs have been filed upon all the points indicated in official regulations in force, and that they show a sufficient *bona fide* compliance with the laws and such regulations. A strict observance of this regulation will be required.

L. HARRISON, Acting Commissioner.

JULY 6, 1883.
Approved:

H. M. TELLER, Secretary.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., December 20, 1883.

Register and Receiver, Leadville, Colorado:

Where consolidated, application filed prior to receipt by you of circular of July 6, entry may be allowed on filing satisfactory proof of five hundred dollars' improvements on each lode claim, the application being otherwise regular.

L. HARRISON, Acting Commissioner.

Approved:

H. M. TELLER, Secretary.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., December 20, 1883.

To Register and Receiver, ——, ——:

GENTLEMEN: Inclosed find copy of telegraphic order this day approved by the honorable Secretary of the Interior. These instructions are intended to apply to all cases where an application for patent embracing more than one lode location had been filed prior to the receipt of circular "N" of this office, approved July 6, 1883.

In regard to similar cases in your office you will be governed by the rule therein stated.

Very respectfully,

L. HARRISON, Acting Commissioner.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., January 14, 1884.

Registers and Receivers:

GENTLEMEN: Your attention is called to the following extract from the decision of the honorable Secretary of the Interior, in case of Charles K. Miner, claimant of the Spencer Lode, *vs.* J. G. Marriott *et al.*, claimants of the Tabor Lode, dated January 4, 1884:

Section 2325 of the Revised Statutes requires, among other things, newspaper publication for the period of sixty days, as notice of application for mineral patent. It also provides that "if no adverse claim shall have been filed with the Register and Receiver of the proper Land Office at the expiration of the sixty days of publication, it shall be assumed that the applicant is entitled to a patent, upon the payment to the proper officer of five dollars per acre, and that no adverse claim exists."

Section 2326 prescribes the method of procedure "where an adverse claim is filed during the period of publication."

For the purpose of deciding the question raised by the appeal, it is only necessary to apply the provisions of law above cited to the facts relative to publication, as disclosed by the record.

These are found to be as follows: The first publication for the Tabor Lode was, as already stated, on the first of June, 1882. The adverse claim of Miner was filed on the third of August, 1882.

Excluding, in accordance with a long established rule of the Department, the first day, we find the third of August to be the sixty-third day of publication.

An apparently plain and simple proposition is thus presented for consideration.

The law requires that an adverse, to be effective, must be filed within the sixty days of publication. Miner's adverse claim was not filed until the sixty-third day. Was it filed within the period prescribed by the law, and has the adverse claimant a legal status as such?

This would admit of no discussion except for the following facts: This Department has held for a number of years (certainly since 1874) that where publication is made in a weekly newspaper, ten insertions are essential in order to show compliance with the law requiring sixty days' publication. In such cases the tenth issue falls on the sixty-third day after the first. In view of this ruling of the Department, your office, in October, 1879, promulgated a decision or order containing the following: "The last, or tenth, insertion being essential, it follows that adverse claims may be filed until the expiration of the day upon which the last issue of such weekly publication is made."

This rule has since been followed by your office, and you therefore recognize as legal and valid the adverse claim of Miner filed on the day of tenth issue of paper containing publication, *i. e.*, on the sixty-third day. In my opinion, the practice of your office referred to is not necessary as a logical result of the rule requiring ten insertions in a weekly paper, nor is it consistent with the law which prescribes the time within which an adverse claim may be filed.

Section 2325 of the Revised Statutes specifically fixes sixty days as the period of publication, and says "if no adverse claim shall have been filed * * * at the expiration of the *sixty days* of publication it shall be assumed that the applicant is entitled to a patent," etc. The regulation requiring ten publications (in a weekly paper), thus in fact making the period sixty-three days instead of sixty, does not alter the law as to sixty days for the filing of an adverse.

The regulation has its reason in the fact that in no other way can the law requiring sixty days' publication be complied with. Nine issues of a weekly paper would not cover the required period. It is true that the tenth insertion carries the publication three days beyond the legally required sixty days, yet, for the purpose of meeting the requirement of law, ten insertions are in fact necessary, since the continuity for sixty days can be preserved only by the tenth publication which falls on the sixty-third day after the first. It is also true that the applicant cannot proceed to complete his entry until after the tenth publication, but this is because it is essential as proof of sixty days' publication. These reasons do not apply to an adverse claimant, and his acts are not controlled thereby. He has the plain letter of the law for his guide. His course is clear and his duty plain. He has sixty days, on any one of which he may file his adverse claim.

If he fails to file within the sixty days of publication prescribed by the law he is barred. So far as he is concerned, the question is one of very simple computation.

It would be equally plain as to the applicant, except for the reasons herein given, and which do not control in considering the rights, either legal or equitable, of an adverse claimant.

* * * * * * * * * * * *

So far as the case under consideration is concerned, however, your decision that the adverse claim was properly received, and therefore dismissing the appeal, is affirmed. The rule of this decision should not operate to interfere with or take away any rights acquired under the law, as it has heretofore been construed by your office. Though that construction is, in my opinion, clearly erroneous, such fact does not render illegal any acts which have been performed in accordance with and pursuant to that construction or interpretation. Until a rule is changed it has all the force of law, and acts done under it while it is in force must be regarded as legal. This view will govern you in the consideration of any similar cases which may arise.

After the receipt of this circular at your office, you will be required to observe strictly the above ruling of the Department.

Very respectfully,

N. C. McFARLAND, Commissioner.

N. CIRCULAR.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., May 11, 1885.

To U. S. Surveyors-General and Registers and Receivers:

GENTLEMEN: Circular "N" of December 4, 1884, is hereby amended as follows:

1. In entries made prior to the receipt by the Register and Receiver of said circular the survey, if free from objection under the former practice, need not be amended to conform to the provisions of paragraph 2 of said circular.

2. All decisions under said circular in conflict with the foregoing amendment may, to that extent, be recalled.

Very respectfully,

WM. A. J. SPARKS, Commissioner.

Approved:

L. Q. C. LAMAR, Secretary.

N. CIRCULAR.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., December 4, 1884.

To United States Surveyors-General and Registers and Receivers:

GENTLEMEN: 1. The rights granted to locators under Section 2322, Revised Statutes, are restricted to such locations on veins, lodes, or ledges as may be "situated on the *public domain*." In applications for lode claims where the survey conflicts with a prior valid lode claim or entry, and the ground in conflict is excluded, the applicant not only has no right to the excluded ground, but he has no right to that portion of any vein or lode the top or apex of which lies within such excluded ground, unless his location was prior to May 10, 1872. His right to the lode claimed terminates where the lode, in its onward course or strike, intersects the exterior boundary of such excluded ground and passes within it.

2. The end-line of his survey should not, therefore, be established beyond such intersection, unless it should be necessary so to do for the purpose of including ground held and claimed under a location which was made upon public land and valid at the time it was made. To include such ground

(which may possibly embrace other lodes) the end-line of the survey may be established within the conflicting survey, but the line must be so run as not to extend any further into the conflicting survey than may be necessary to make such end-line parallel to the other end-line, and at the same time embrace the ground so held and claimed. The useless practice in such cases of extending *both* the side lines of a survey into the conflicting survey and establishing an end-line wholly within it, beyond a point necessary under the rule just stated, will be discontinued.

3. These instructions will be observed by Surveyors-General in all cases where surveys have not been approved by them prior to receipt hereof.

4. If, however, a survey under the old practice has been approved by the Surveyor-General prior to the receipt by him of these instructions application for patent thereon, if otherwise regular, will not be rejected.

5. In applications filed prior to receipt hereof at the local Land Office, and applications allowed under the preceding paragraph, entry will be allowed as heretofore, when the necessary proofs under former regulations are complete.

6. In case of applications and entries allowed under paragraphs four and five, amendment of the survey will be directed by this office, if found necessary.

7. After the receipt of this circular at the local Land Office all applications for mineral patents, applications to purchase, Register's final certificates of entry, and Receiver's receipts, must not only describe the ground claimed, but must state specifically what conflict or conflicts with other surveys, lots, or claims are excluded, giving the number of each conflicting survey or lot. The published and posted notices must contain the same information.

8. As this circular does not affect any rights which an applicant has under the law, its enforcement in pending cases cannot operate injuriously, and it will therefore be carried into effect at once in the adjudication of cases by this office. In the form of patents to be issued the same rule will go into operation as soon as the necessary blanks and records can be prepared.

9. A strict observance of these regulations will be required.

Very respectfully,

N. C. McFARLAND, Commissioner.

Approved:

H. M. TELLER, Secretary.

N. **CIRCULAR.**

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., December 14, 1885.

To Registers and Receivers and Surveyors-General:

GENTLEMEN: 1. For reasons stated in decision dated October 31, 1885, in the case of the Good Return Placer Mine (4 L. D. 221), the Hon. Secretary of the Interior holds that the "circular instructions of ninth December, 1882, and the first requirement of the circular of eighth June, 1883, are erroneous, and the same are accordingly overruled."

2. Said decision also holds: That the annual expenditure to the amount of $100, required by Section 2324, Revised Statutes, must be made upon placer claims as well as lode claims.

3. That "compliance 'with the terms of this chapter,' as a condition

for the making of application for patent according to Section 2325, requires the preliminary showing of work or expenditure upon each location, sufficient to the maintenance of possession under Section 2324, either by showing the full amount for the pending year, or if there has been failure it should be shown that work has been resumed so as to prevent relocation by adverse parties after abandonment."

4. "That as Section 2325 only directs proof of expenditure to the amount of five hundred dollars by certificate of the Surveyor-General on the claim embraced in the application for patent, it must be error to hold that it further requires that amount on each individual original location, in lieu of the amount already provided for by Section 2324."

5. Registers will, therefore, before receiving any applications or permitting entry upon applications already made, require a satisfactory preliminary showing of work or expenditure, under paragraph 3 hereof, upon or for the benefit of each location embraced in the claim, which may, where the matter is unquestioned, consist of the affidavit of the applicant, clearly and specifically setting out all the *facts* constituting the compliance with the law by himself or grantors. Where application is made by an incorporated company, or where an applicant satisfactorily shows by affidavit that he is not personally acquainted with the facts, the applicant's affidavit may be made by the duly authorized agent who has such knowledge, but whether made by principal or agent it must be specifically and fully corroborated by the affidavits of at least two disinterested and credible witnesses familiar with the facts. This showing must include the year in which the application for patent is filed. The evidence specified in paragraph 32 of Circular N of October 31, 1881, will still be required. Where the abstract of title is dated prior to the date of filing the application for patent, a continuation of the abstract to and including such date must be filed before the applicant is allowed to make entry.

6. Where an application for patent embraces several locations or claims *held in common*, constituting one entire claim, whether lode or placer, an expenditure of five hundred dollars, under Section 2325, R. S., upon such entire claim embraced in the application, will be sufficient and need not be shown upon each of the locations included therein.

You will observe carefully the modification of the practice and regulations as above indicated.

WM. A. J. SPARKS, Commissioner.

Approved December 15, 1885:

L. Q. C. LAMAR, Secretary.

TIMBER AND STONE LANDS.

An Act for the Sale of Timber Lands in the States of California, Oregon, Nevada, and in Washington Territory. (Approved June 3, 1878. U. S. Stats., v. 20, p. 89.)

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That surveyed public lands of the United States, within the States of California, Oregon, and Nevada, and in Washington Territory, not included within military, Indian, or other reservations of the United States, valuable chiefly for timber, but unfit for cultivation, and which have not been offered at public sale, according to law, may be sold to citizens of the United States, or persons

who have declared their intention to become such, in quantities not exceeding one hundred and sixty acres to any one person, or association of persons, at the minimum price of two dollars and fifty cents per acre; and lands valuable chiefly for stone may be sold on the same terms as timber lands; *provided*, that nothing herein contained shall defeat or impair any bona fide claim under any law of the United States, or authorize the sale of any mining claim, or the improvements of any *bona fide* settler, or lands containing gold, silver, cinnabar, copper, or coal, or lands selected by the said States under any law of the United States donating lands for internal improvements, education, or other purposes; *and provided further*, that none of the rights conferred by the Act approved July twenty-sixth, eighteen hundred and sixty-six, entitled "An Act granting the right of way to ditch and canal owners over the public lands, and for other purposes," shall be abrogated by this Act; and all patents granted shall be subject to any vested and accrued water rights, or rights to ditches and reservoirs used in connection with such water rights as may have been acquired under and by the provisions of said Act; and such rights shall be expressly reserved in any patent issued under this Act.

SEC. 2. That any person desiring to avail himself of the provisions of this Act, shall file with the Register of the proper district a written statement in duplicate, one of which is to be transmitted to the General Land Office, designating, by legal subdivisions, the particular tract of land he desires to purchase, setting forth that the same is unfit for cultivation, and valuable chiefly for its timber or stone, that it is uninhabited, contains no mining or other improvements, except for ditch or canal purposes, where any such do exist, save such as were made by or belong to the applicant, nor, as deponent verily believes, any valuable deposit of gold, silver, cinnabar, copper, or coal; that deponent has made no other application under this Act; that he does not apply to purchase the same on speculation, but in good faith to appropriate it to his own exclusive use and benefit; and that he has not, directly or indirectly, made any agreement or contract, in any way or manner, with any person or persons whatsoever, by which the title which he might acquire from the Government of the United States should inure, in whole or in part, to the benefit of any person except himself; which statement must be verified by the oath of the applicant before the Register or the Receiver of the Land Office within the district where the land is situated; and if any person taking such oath shall swear falsely in the premises he shall be subject to all the pains and penalties of perjury, and shall forfeit the money which he may have paid for said lands, and all right and title to the same; and any grant or conveyance which he may have made, except in the hands of *bona fide* purchasers, shall be null and void.

SEC. 3. That upon the filing of said statement, as provided in the second section of this Act, the Register of the Land Office shall post a notice of such application, embracing a description of the land by legal subdivisions, in his office, for a period of sixty days, and shall furnish the applicant a copy of the same for publication, at the expense of such applicant, in a newspaper published nearest the location of the premises, for a like period of time; and after the expiration of said sixty days, if no adverse claim shall have been filed, the person desiring to purchase shall furnish to the Register of the Land Office satisfactory evidence: first, that said notice of the application prepared by the Register as aforesaid, was duly published in a newspaper as herein required; secondly, that the land is of the character contemplated in this Act, unoccupied and without improvements, other than those excepted, either mining or agricultural,

and that it apparently contains no valuable deposits of gold, silver, cinnabar, copper, or coal; and upon payment to the proper officer of the purchase money of said land, together with the fees of the Register and the Receiver, as provided for in case of mining claims in the twelfth section of the Act, approved May tenth, eighteen hundred and seventy-two, the applicant may be permitted to enter said tract, and, on the transmission of the General Land Office of the papers and testimony in the case, a patent shall issue thereon; *provided*, that any person having a valid claim to any portion of the land may object, in writing, to the issuance of a patent to lands so held by him, stating the nature of his claim thereto; and evidence shall be taken, and the merits of said objection shall be determined by the officers of the Land Office, subject to appeal, as in other land cases. Effect shall be given to the foregoing provisions of this Act by regulations to be prescribed by the Commissioner of the General Land Office.

Sec. 4. That after the passage of this Act it shall be unlawful to cut, or cause or procure to be cut, or wantonly destroy any timber growing on any lands of the United States, in said States and Territory, or remove, or cause to be removed, any timber from said public lands, with intent to export or dispose of the same; and no owner, master, or consignee of any vessel, or owner, director, or agent of any railroad, shall knowingly transport the same, or any lumber manufactured therefrom; and any person violating the provisions of this section shall be guilty of a misdemeanor, and, on conviction, shall be fined for every such offense a sum not less than one hundred nor more than one thousand dollars; *provided*, that nothing herein contained shall prevent any miner or agriculturist from clearing his land in the ordinary working of his mining claim, or preparing his farm for tillage, or from taking the timber necessary to support his improvements, or the taking of timber for the use of the United States; and the penalties herein provided shall not take effect until ninety days after the passage of this Act.

Sec. 5. That any person prosecuted in said States and Territory for violating section two thousand four hundred and sixty-one of the Revised Statutes of the United States, who is not prosecuted for cutting timber for export from the United States, may be relieved from further prosecution and liability therefor upon payment, into the Court wherein such action is pending, of the sum of two dollars and fifty cents per acre for all lands on which he shall have cut, or caused to be cut, timber, or removed, or caused to be removed, the same; *provided*, that nothing contained in this section shall be construed as granting to the person hereby relieved, the title to said lands for said payment; but he shall have the right to purchase the same upon the same terms and conditions as other persons, as provided hereinbefore in this Act; *and further provided*, that all moneys collected under this Act shall be covered into the Treasury of the United States, and section four thousand seven hundred and fifty-one of the Revised Statutes is hereby repealed, so far as it relates to the States and Territory herein named.

Sec. 6. That all Acts and parts of Acts inconsistent with the provisions of this Act are hereby repealed.

TO FIND THE VALUE OF GOLD OR SILVER OF A SPECIMEN.

(By C. H. Aaron.)

There are many rules for ascertaining the proportion of gold in specimens, all based on the different densities of the specimens as a whole, of the gold, and of the quartz. The specific gravity of the gold and of the quartz is generally assumed, the former at 17 to 19, the latter at 2.6. That of the specimen is found by weighing it in air and in water, and dividing its weight in air by the difference. In this case, the easiest rule to remember is this: Divide the specific gravity of the gold by that of the quartz and by that of the specimen. From the greater quotient subtract the lesser; the remainder is the proportion of gold. From the lesser quotient subtract 1; the remainder is the proportion of quartz. Then as the sum of these proportional quantities is to the proportion of gold, so is the weight of the specimen to the actual quantity of gold in it. Suppose a specimen weighs 32 ounces in air and 28 ounces in water; the difference is 4, and 32 divided by 4 gives 8, which is the specific gravity of the specimen. If the specific gravity of the gold is assumed to be 17, and that of the quartz 2.6, we have 17 divided by 2.6, gives 6.539 nearly, and 17 divided by 8 gives 2.125. Subtracting the lesser quotient from the greater leaves 4.414, and subtracting 1 from the lesser leaves 1.125, and the proportion is 4.414 ounces of gold to 1.125 of quartz. Adding these together we have 5.539. Now it is a mere question in the rule of three. If 5.539 ounces of the specimen contain 4.414 ounces of gold, how much does the whole specimen weighing 32 ounces contain? Answer, 25.5 ounces. This is correct provided the assumed specific gravities of the gold and gangue are correct; but if greater accuracy be desired, proceed thus: Weigh the specimen, a piece of the metal, and a piece of the gangue, each in air and water. Divide the difference between the respective weights in air and in water by the weights in air. From the greater quotient subtract the next less, and from that the least. The first remainder is the proportional weight of the metal, the second is that of the gangue; the sum of these is that of the specimen. Having the actual weight of the specimen, that of the metal is easily found, as before, by the rule of three.

Suppose a specimen of native silver in spar weighs 84 pounds in air and 73.5 in water; a piece of the silver weighs 27 grains in air and 24 in water; a piece of the spar 20 in air and 12 in water. Then—

Spar in air	20
Spar in water	12
Difference	8÷20=0.400.
Specimen in air	84
Specimen in water	73.5
Difference	10.5÷84=0.125.

Silver in air	27
Silver in water	24
Difference	3÷27=0.111.

And 400 − 125 = 275 = proportion of silver.
And 125 − 111 = 14 = proportion of spar.

289 = proportion of specimen.

Then 289:275::84:79.93 pounds of silver in specimen.

The weight of the object in air divided by its difference in water is the specific gravity. The difference divided by the weight in air is the specific displacement. From either of these, the proportional quantities of two different substances composing a mixture can be determined by the rules given for the valuation of specimens.

TABLES.

The following tables and figures are taken from "Practical Hydraulics," by P. M. Randall:

QUANTITY OF WATER REQUIRED FOR QUARTZ MINING.

The contents of one ton of quartz, in its normal condition in the lode, is estimated at 13 cubic feet, and at 20 cubic feet when the quartz is broken, as it usually comes from the mine. Adopting the lode measurement, it is seen that a cubic yard of quartz is $27 \div 13 = 2.08$ tons, nearly. Experience shows that the duty of a miner's inch is as follows: Duty of a miner's inch (under 4-inch pressure) in the reduction and amalgamation of silver ores in a "stamp silver mill," Nevada, 3.25 cubic yards, or 6.76 tons; in the reduction and amalgamation by riffles, or copper plate, in "stamp gold mill," California, 5.78 cubic yards, or 12 tons. Duty of miner's inch under 7-inch pressure, in the former case (silver), 4.3 cubic yards, or 8.93 tons; in the latter case (gold), 6.65 cubic yards, or 15.88 tons. The volume of water to that of ore is, in working silver ores, Nevada, 19.5 to 1; in working gold ores, California, 11.1 to 1; in working copper ores, Lake Superior, 20 to 1.

MEASUREMENT OF THE POWER OF WATER AS A MOTOR.

The unit in the measurement of power is a foot-pound—that is, the amount of energy necessary to raise one pound weight vertically through a distance of one foot. On the other hand, one pound falling by the force of gravity through a distance of one foot, generates a foot-pound. The amount of energy required to raise one pound vertically 550 feet, is equal to the amount of energy necessary to raise 550 pounds vertically one foot in height. This amount of energy rendered in one second is termed a horse-power—that is, 550 foot-pounds rendered in one second, is the value of a horse-power in mechanics.

The weight of a cubic foot of fresh water is estimated in practice at 62.5 pounds. Ex.—How many horse-power will 10 cubic feet of water, applied to an overshot water wheel, 40 feet diameter, render, the efficiency of the wheel being 75 per cent, and one foot being allowed for clearance? Cal.— $40 - 1 = 39$ feet, effective head; $62.5 \times 10 \times 39 \times .75 \div 550 = 33.24$ horse-power. Ans.

MISCELLANIES.

One cubic foot of distilled water (U. S. standard), barometer 30 inches, 39.83° Fahr., equals 62.3793 pounds.

One cubic foot of distilled water (British standard), barometer 30 inches, 62° Fahr., equals 62.321 pounds.

One cubic foot of distilled water (U. S. standard), equals 7.48052 gallons.

One cubic inch of distilled water (U. S. standard), equals 0.0361 pounds.

One gallon (U. S. standard), equals 231 cubic inches, equals 0.133681 cubic feet, equals 8.3389 pounds water.

One gallon, imperial (British standard), equals 277.123 cubic inches, equals 0.160372 cubic feet, equal 10 pounds water.

One gallon (N. Y. statute measure), barometer 30 inches, 39.83° Fahr., equals 221.184 cubic inches, equals 8 pounds water.

One pound avoirdupois equals 16 ounces, equals 7,000 grains (U. S. standard), equals 27.7015 cubic inches.

One pound troy equals 1 pound apothecary, equals 12 ounces, equals 5,760 grains.

One ounce avoirdupois equals 437.5 grains.

One ounce troy equals one ounce apothecary, equals 480 grains.

One chain equals 100 links, equals 4 rods, equals 66 feet, equals 792 inches.

Eighty chains equal 1 statute mile, equals 320 rods, equals 1,760 yards, equals 5,280 feet, equals 63,260 inches.

One geographical, nautical, or sea mile equals 6,086.5 feet in longitude, and 6,076.5 feet in latitude.

One league (English), equals 3 nautical miles.

One metre equals 3.2808992 feet, equals 3.281 feet in practice.

One square metre equals 1 centiare, equals 10.7643 square feet.

One are equals 100 square meters, equals 1076.43 square feet.

One cubic meter equals 1 stare, equals 35.3166 cubic feet.

One vara equals 2.75 feet.

One legua (Mexican) equals 5,000 varas linear, equals 13,750 feet, equals 2.60417 miles.

One hundred vara lot equals 100 varas square, equals 75,625 square feet, equals 1.73611 acres.

One legua (Mexican, of land) equals 6.7817 square miles, equals 4340.-27778 acres.

One acre equals 4 roods, equals 10 square chains, equals 160 square rods, equals 43,560 square feet.

One section equals 1 square mile, equals 640 acres.

One township equals 36 sections, equals 6 miles square, equals 36 square miles.

One cubic yard equals 27 cubic feet, equals 16,656 cubic inches.

One hundred weight (British) equals 8 stone, equals 112 pounds.

One ton (long ton) commercial, equals 20-hundred weight, equals 2240 pounds.

One ton (short ton) U. S., equals 2000 pounds.

One quintal equals 100 pounds.

One fathom equals 6 feet; 1 cable length equals 120 fathoms.

One point equals $\frac{1}{72}$ of an inch.

One line equals 6 points, equals $\frac{1}{12}$ of an inch.

Twelve inches equals 1 foot; 3 feet equals 1 yard.

Five and one half yards equals 1 rod.

One foot board measure equals 1 foot square and 1 inch thick.

Twelve feet board measure equals 1 cubic foot.

One foot-pound equals work required to raise one pound vertically one foot.

One second foot-pound equals work required to raise one pound vertically one foot in one second of time.

One minute foot-pound equals work required to raise one pound vertically one foot in one minute.

One degree (1°), centigrade, equals 1.8° (degrees), Fahrenheit.

One barometric inch equals column of mercury, with one square inch base and one inch high.

Atmospheric pressure per square inch equals 14.7 pounds equals 30 barometric inches nearly, at 39.83° Fahr.

One ounce Troy, gold, 1,000 fine, equals $20.6718.

One ounce Troy, gold coin, U. S., 900 fine, equals $18.6046.

One pound avoirdupois, gold coin, U. S., 900 fine, equals $271.375.

One ounce Troy, silver, 1,000 fine, equals $1.29293.*

One ounce Troy, silver, U. S., 900 fine, equals $1.163636.*

One pound avoirdupois, silver coin, U. S., 900 fine, equals $16.96969.

One dollar, U. S. gold coin, equals 23.22 grains gold × 2.58 grains copper, equals 25.8 grains.

One dollar, U. S. silver coin, equals 371.25 grains silver × 41.25 grains copper, equals 412.5 grains.

One pound sterling equals 1 sovereign, equals 113.001 grains gold × 10.273 grains copper, equals 123.274 grains weight, fineness 22 carats, equals 916.6667.

One grain gold, 1,000 fine, equals $.0430663, mint value.

One grain silver, 1,000 fine, equals $.0026936, mint value.

One gramme gold, 1,000 fine, equals $.6646142, mint value.

One gramme silver, 1,000 fine, equals $.0415686, mint value.

One cubic foot air equals .0806726 pounds, equals 564.7082 grains.

One pound of air at 39.83° equals 12.387 cubic feet by volume.

One cubic foot hydrogen equals .005042 pounds, equals 35.2743 grains.

Twenty-five cubic feet of sand equals 1 ton.

Eighteen cubic feet of earth equals 1 ton.

Seventeen cubic feet of clay equals 1 ton.

Thirteen cubic feet of quartz, unbroken in lode, equals 1 ton.

Eighteen cubic feet of gravel or earth, before digging, equals 27 cubic feet when dug.

Twenty cubic feet of quartz, broken (of ordinary fineness, coming from the lode), equals 1 ton, contract measurement.

One horse-power (H. P.) equals 550 second foot-pounds, equal 33,000 minute foot-pounds.

One hundred libras (Mexico)=1 quintal=46,025.00 grammes=101.5 pounds avoirdupois.

AVOIRDUPOIS OUNCES TO TROY OUNCES.

Avoirdupois Ounces.	Troy Ounces.	Avoirdupois Ounces.	Troy Ounces.	Avoirdupois Ounces.	Troy Ounces.
1	0.911	7	6.380	13	11.849
2	1.823	8	7.292	14	12.760
3	2.734	9	8.203	15	13.672
4	3.646	10	9.115	16	14.583
5	4.557	11	10 026		
6	5.469	12	10.397		

437.5 grains equals 1 avoirdupois ounce.
480 grains equals 1 troy ounce.

*Subject to discount.

Avoirdupois Pounds to Troy Ounces.

Pounds.	Ounces.	Pounds.	Ounces.	Pounds.	Ounces.
1	14.583	10	145.833	100	1458.333
2	29.167	20	291.667	200	2916.667
3	43.750	30	437.500	300	4375.000
4	58.333	40	583.333	400	5833.333
5	72.917	50	729.167	500	7291.667
6	87.500	60	875.000	600	8750.000
7	102.083	70	1020.833	700	10208.333
8	116.667	80	1166.667	800	11666.667
9	131.250	90	1312.500	900	13125.000

Table Showing the Melting Points of Metals.

Metal.	Centigrade.	Fahrenheit.	Metal.	Centigrade.	Fahrenheit.
Aluminium	700°	1292°	Iron, steel	1400°	2552°
Antimony	425°	797°	Lead	334°	617°
Arsenic	185°	365°	Magnesium	235°	455°
Bismuth	264°	507.°2	Mercury	— 40°	*654.°8
Cadmium	320°	608°	Nickel	1600°	2912°
Cobalt	1200°	2192°	Potassium	62°	143.°6
Copper	1091°	1995.°8	Platinum	2600°	4712°
Gold	1381°	2485.°8	Silver	1040°	1904°
Indium	176°	348.°8	Sodium	96°	172.°8
Iron, wrought	1530°	2786°	Tin	235°	455°
Iron, cast	1200°	2192°	Zinc	412°	773.°6

Amalgams.

Gold—One weight of mercury amalgamates with two weights of gold.
Silver—10 silver to 19 mercury.
Tin—1 tin to 3 mercury, for looking-glasses.
1 tin, 1 lead, 2 bismuth, 10 mercury, for glass globes.
1 tin, 1 zinc, 3 mercury, for rubbers in electric machines.

Metrical System. Measures of Length.

	In Inches.	In Feet.	In Yards.	In Fathoms.	In Miles.
Millimetre	.03937	.003281	.0010936	.0005468	.0000006
Centimetre	.39371	.032809	.0109363	.0056482	.0000062
Decimetre	3.93708	.328090	.1093633	.0546816	.0000621
Metre	39.37079	3.280899	1.0936331	.5468165	.0006214
Decametre	393.70790	32.808992	10.9363306	5.4681653	.0062138
Hectometre	3937.07900	328.089917	109.3633056	54.6816528	.0621382
Kilometre	39370.7900	3280.899167	1093.6330556	546.8165278	.6213824
Myriametre	393707.9000	32808.991667	10936.3305556	5468.1652778	6.2138242

1 inch equals 2.539954 centimetres.
1 foot equals 3.0479449 decimetres.
1 yard equals 0.9143835 metre.
1 mile equals 1.06093149 kilometre.

* Boils.

Measures of Surface.

	In Square Feet.	In Square Yards.	In Poles.	In Roods.	In Acres.
Centiare, square metre	10.764299	1.196033	.0395383	.0009885	.0002471
Are, 100 square metres	1076.429934	119.603326	3.9538290	.0988457	.0247114
Hectare, 10,000 square metres	107642.993419	11960.332602	395.3828959	9.8845724	2.4711431

1 square inch equals 6.4514669 square centimetres.
1 square foot equals 9.2899683 square decimetres.
1 square yard equals .83609715 square metre.
1 acre equals .40467102 hectare.
1 square mile equals 2.58989451 hectares.

Measures of Capacity.

	In Cubic Inches.	In Cubic Feet.	In Pints.	In Gallons.	In Bushels.
Millilitre cubic centimetres	.06103	.000035	.00176	.0002201	.0000275
Litre or cubic decimetre	61.02705	.035317	1.76077	.2200967	.0275121

1 cubic inch equals 16.386176 cubic centimetres.
1 cubic foot equals 28.315312 cubic decimetres.
1 gallon equals 4.543458 litres.

Measures of Weights.

	In Grains.	In Troy Ounces.	In Avoirdupois Pounds.	In Cwts.	In Tons.
Milligram	.01543	.000032	.0000022	.0000000	.0000000
Centigram	.15432	.000322	.0000220	.0000002	.0000000
Decigram	1.54323	.003215	.0002205	.0000020	.0000001
Gram	15.43235	.032151	.0022046	.0000197	.0000010

1 grain equals .064799 gram.
1 pound avoirdupois equals .453593 kilogram.
1 troy ounce equals 31.103496 grams.
1 cwt. equals 50.802377 kilograms.

CHAPTER IV, PART II, TITLE III, POLITICAL CODE OF THE STATE OF CALIFORNIA.

LEGAL DISTANCES IN THE STATE.

150. *Legal Distances.*

Sec. 150. The legal distances in this State are fixed as follows:

151. *Alameda.*

Sec. 151. From the county seat of Alameda County to Sacramento, ninety-one (91) miles; to Napa, forty-six (46) miles; to Stockton, eighty-five (85) miles; to San Quentin, nineteen (19) miles.

152. *Alpine.*

Sec. 152. From the county seat of Alpine County to Sacramento, two hundred and twenty-five (225) miles; to Napa, two hundred and eighty-six (286) miles; to Stockton, two hundred and seventy-three (273) miles; to San Quentin, three hundred and twenty-one (321) miles.

153. *Amador.*

Sec. 153. From the county seat of Amador County to Sacramento, fifty-nine (59) miles; to Napa, one hundred and ten (110) miles; to Stockton, fifty-seven (57) miles; to San Quentin, one hundred and forty-five (145) miles.

154. *Butte.*

Sec. 154. From the county seat of Butte County to Sacramento, seventy-eight (78) miles; to Napa, one hundred and thirty-nine (139) miles; to Stockton, one hundred and twenty-six (126) miles; to San Quentin, one hundred and seventy-four (174) miles.

155. *Calaveras.*

Sec. 155. From the county seat of Calaveras County to Sacramento, seventy-three (73) miles; to Napa, one hundred and thirty-four (134) miles; to Stockton, sixty (60) miles; to San Quentin, one hundred and sixty-four (164) miles.

156. *Colusa.*

Sec. 156. From the county seat of Colusa County to Sacramento, eighty (80) miles; to Napa, one hundred and forty-one (141) miles; to Stockton, one hundred and twenty-eight (128) miles; to San Quentin, one hundred and seventy-six (176) miles.

157. *Contra Costa.*

Sec. 157. From the county seat of Contra Costa County to Sacramento,

eighty-nine (89) miles; to Napa, twenty-seven (27) miles; to Stockton, one hundred and twenty-one (121) miles; to San Quentin, forty-one (41) miles. [Amendment approved March 14, 1878; amendments 1877–1878; in force from passage.]

158. *Del Norte.*

Sec. 158. From the county seat of Del Norte County to Sacramento, three hundred and sixty-four (364) miles; to Napa, three hundred and nineteen (319) miles; to Stockton, three hundred and seventy-two (372) miles; to San Quentin, two hundred and ninety-two (292) miles.

159. *El Dorado.*

Sec. 159. From the county seat of El Dorado County to Sacramento, sixty-one (61) miles; to Napa, one hundred and twenty-two (122) miles; to Stockton, one hundred and nine (109) miles; to San Quentin, one hundred and fifty-seven (157) miles.

160. *Fresno.*

Sec. 160. From the county seat of Fresno County to Sacramento, one hundred and sixty-nine (169) miles; to Napa, two hundred and thirty (230) miles; to Stockton, one hundred and thirteen (113) miles; to San Quentin, two hundred and seven (207) miles.

161. *Humboldt.*

Sec. 161. From the county seat of Humboldt County to Sacramento, three hundred and twelve (312) miles; to Napa, two hundred and sixty-seven (267) miles; to Stockton, three hundred and twenty (320) miles; to San Quentin, two hundred and forty (240) miles.

162. *Inyo.*

Sec. 162. From the county seat of Inyo County to Sacramento, four hundred and seventy-one (471) miles; to Napa, five hundred and thirty-two (532) miles; to Stockton, four hundred and twenty-three (423) miles; to San Quentin, five hundred and eight (508) miles.

163. *Kern.*

Sec. 163. From the county seat of Kern County to Sacramento, two hundred and seventy-eight (278) miles; to Napa, three hundred and thirty-nine (339) miles; to Stockton, two hundred and thirty (230) miles; to San Quentin, three hundred and fifteen (315) miles.

164. *Lake.*

Sec. 164. From the county seat of Lake County to Sacramento, two hundred and four (204) miles; to Napa, one hundred and fifty-nine (159) miles; to Stockton, two hundred and twelve (212) miles; to San Quentin, one hundred and thirty-two (132) miles.

165. *Lassen.*

Sec. 165. From the county seat of Lassen County to Sacramento, one hundred and eighty-three (183) miles; to Napa, two hundred and forty-

four (244) miles; to Stockton, two hundred and thirty-one (231) miles; to San Quentin, two hundred and seventy-nine (279) miles.

166. *Los Angeles.*

SEC. 166. From the county seat of Los Angeles County to Sacramento, four hundred and seventy-eight (478) miles; to Napa, four hundred and thirty-three (433) miles; to Stockton, four hundred and eighty-six (486) miles; to San Quentin, four hundred and six (406) miles.

167. *Marin.*

SEC. 167. From the county seat of Marin County to Sacramento, ninety-six (96) miles; to Napa, fifty-one (51) miles; to Stockton, one hundred and four (104) miles; to San Quentin, three (3) miles.

168. *Mariposa.*

SEC. 168. From the county seat of Mariposa County to Sacramento, one hundred and fifty-six (156) miles; to Napa, two hundred and seventeen (217) miles; to Stockton, one hundred and nine (109) miles; to San Quentin, one hundred and ninety-three (193) miles.

169. *Mendocino.*

SEC. 169. From the county seat of Mendocino County to Sacramento, two hundred and five (205) miles; to Napa, one hundred (100) miles; to Stockton, two hundred and thirteen (213) miles; to San Quentin, one hundred and thirty-three (133) miles.

170. *Merced.*

SEC. 170. From the county seat of Merced County to Sacramento, one hundred and fourteen (114) miles; to Napa, one hundred and seventy-five (175) miles; to Stockton, sixty-six (66) miles; to San Quentin, one hundred and fifty-two (152) miles.

171. *Modoc.*

SEC. 171. From the county seat of Modoc County to Sacramento, three hundred and seventy-nine (379) miles; to Napa, four hundred and forty (440) miles; to Stockton, four hundred and twenty-seven (427) miles; to San Quentin, four hundred and seventy-five (475) miles.

172. *Mono.*

SEC. 172. From the county seat of Mono County to Sacramento, two hundred and ninety-six (296) miles; to Napa, three hundred and fifty-seven (357) miles; to Stockton, three hundred and forty-four (344) miles; to San Quentin, three hundred and ninety-two (392) miles.

173. *Monterey.*

SEC. 173. From the county seat of Monterey County to Sacramento, one hundred and ninety-six (196) miles; to Napa, one hundred and fifty-seven (157) miles; to Stockton, one hundred and forty-eight (148) miles; to San Quentin, one hundred and thirty (130) miles.

174. *Napa.*

Sec. 174. From the county seat of Napa County to Sacramento, sixty-one (61) miles; to Stockton, eighty-seven (87) miles; to San Quentin, fifty-one (51) miles.

175. *Nevada.*

Sec. 175. From the county seat of Nevada County to Sacramento, seventy-one (71) miles; to Napa, one hundred and thirty-two (132) miles; to Stockton, one hundred and nineteen (119) miles; to San Quentin, one hundred and sixty-seven (167) miles.

176. *Placer.*

Sec. 176. From the county seat of Placer County to Sacramento, thirty-seven (37) miles; to Napa, ninety-eight (98) miles; to Stockton, eighty-five (85) miles; to San Quentin, one hundred and thirty-three (133) miles.

177. *Plumas.*

Sec. 177. From the county seat of Plumas County to Sacramento, one hundred and thirty-six (136) miles; to Napa, one hundred and ninety-seven (197) miles; to Stockton, one hundred and eighty-four (184) miles; to San Quentin, two hundred and thirty-two (232) miles.

178. *Sacramento.*

Sec. 178. From the county seat of Sacramento County to Napa, sixty-one (61) miles; to Stockton, forty-eight (48) miles; to San Quentin, ninety-six (96) miles.

179. *San Benito.*

Sec. 179. From the county seat of San Benito County to Sacramento, one hundred and seventy-three (173) miles; to Napa, one hundred and thirty-four (134) miles; to Stockton, one hundred and twenty-five (125) miles; to San Quentin, one hundred and seven (107) miles.

180. *San Bernardino.*

Sec. 180. From the county seat of San Bernardino County to Sacramento, five hundred and eighty-eight (588) miles; to Napa, five hundred and forty-three (543) miles; to Stockton, five hundred and thirty (530) miles; to San Quentin, five hundred and sixteen (516) miles.

181. *San Diego.*

Sec. 181. From the county seat of San Diego County to Sacramento. five hundred and sixty-six (566) miles; to Napa, five hundred and twenty-one (521) miles; to Stockton, five hundred and seventy-four (574) miles; to San Quentin, four hundred and ninety-four (494) miles. [Amendment, approved March 27, 1878. Amendments, 1877-8; in full force from passage.]

182. *San Francisco.*

Sec. 182. From the county seat of San Francisco County to Sacramento. eighty-four (84) miles; to Napa, thirty-nine (39) miles; to Stockton, ninety-two (92) miles; to San Quentin, twelve (12) miles.

183. *San Joaquin.*

Sec. 183. From the county seat of San Joaquin County to Sacramento, forty-eight (48) miles; to Napa, eighty-seven (87) miles; to San Quentin, one hundred and four (104) miles.

184. *San Luis Obispo.*

Sec. 184. From the county seat of San Luis Obispo County to Sacramento, two hundred and ninety-three (293) miles; to Napa, two hundred and forty-eight (248) miles; to Stockton, two hundred and eighty-seven (287) miles; to San Quentin, two hundred and twenty-one (221) miles.

185. *San Mateo.*

Sec. 185. From the county seat of San Mateo County to Sacramento, one hundred and five (105) miles; to Napa, sixty (60) miles; to Stockton, one hundred and thirteen (113) miles; to San Quentin, thirty-three (33) miles.

186. *Santa Barbara.*

Sec. 186. From the county seat of Santa Barbara County to Sacramento, three hundred and sixty-nine (369) miles; to Napa, three hundred and twenty-four (324) miles; to Stockton, three hundred and seventy-seven (377) miles; to San Quentin, two hundred and ninety-seven (297) miles.

187. *Santa Clara.*

Sec. 187. From the county seat of Santa Clara County to Sacramento, one hundred and twenty-eight (128) miles; to Napa, eighty-nine (89) miles; to Stockton, eighty (80) miles; to San Quentin, sixty-two (62) miles.

188. *Santa Cruz.*

Sec. 188. From the county seat of Santa Cruz County to Sacramento, two hundred and five (205) miles; to Napa, one hundred and sixty (160) miles; to Stockton, one hundred and fifty-one (151) miles; to San Quentin, one hundred and thirty-three (133) miles.

189. *Shasta.*

Sec. 189. From the county seat of Shasta County to Sacramento, one hundred and seventy-seven (177) miles; to Napa, two hundred and thirty-eight (238) miles; to Stockton, two hundred and twenty-five (225) miles; to San Quentin, two hundred and seventy-three (273) miles.

190. *Sierra.*

Sec. 190. From the county seat of Sierra County to Sacramento, one hundred and nineteen (119) miles; to Napa, one hundred and seventy (170) miles; to Stockton, one hundred and sixty-seven (167) miles; to San Quentin, two hundred and fifteen (215) miles.

191. *Siskiyou.*

Sec. 191. From the county seat of Siskiyou County to Sacramento, two hundred and eighty-five (285) miles; to Napa, three hundred and forty-six

(346) miles; to Stockton, three hundred and thirty-three (333) miles; to San Quentin, three hundred and seventy-one (371) miles.

192. *Solano.*

Sec. 192. From the county seat of Solano County to Sacramento, forty (40) miles; to Napa, twenty-one (21) miles; to Stockton, eighty-eight (88) miles; to San Quentin, fifty-six (56) miles.

193. *Sonoma.*

Sec. 193. From the county seat of Sonoma County to Sacramento, one hundred and forty-one (141) miles; to Napa, thirty-five (35) miles; to Stockton, one hundred and forty-nine (149) miles; to San Quentin, sixty-nine (69) miles.

194. *Stanislaus.*

Sec. 194. From the county seat of Stanislaus County to Sacramento, seventy-seven (77) miles; to Napa, one hundred and thirty-eight (138) miles; to Stockton, thirty (30) miles; to San Quentin, one hundred and fourteen (114) miles.

195. *Sutter.*

Sec. 195. From the county seat of Sutter County to Sacramento, fifty (50) miles; to Napa, one hundred and eleven (111) miles; to Stockton, ninety-eight (98) miles; to San Quentin, one hundred and forty-six (146) miles.

196. *Tehama.*

Sec. 196. From the county seat of Tehama County to Sacramento, one hundred and thirty-five (135) miles; to Napa, one hundred and ninety-six (196) miles; to Stockton, one hundred and eighty-three (183) miles; to San Quentin, two hundred and thirty-one (231) miles.

197. *Trinity.*

Sec. 197. From the county seat of Trinity County to Sacramento, two hundred and seventeen (217) miles; to Napa, two hundred and seventy-eight (278) miles; to Stockton, two hundred and sixty-five (265) miles; to San Quentin, three hundred and thirteen (313) miles.

198. *Tulare.*

Sec. 198. From the county seat of Tulare County to Sacramento, two hundred and eleven (211) miles; to Napa, two hundred and seventy-two (272) miles; to Stockton, one hundred and sixty-three (163) miles; to San Quentin, two hundred and forty-nine (249) miles.

199. *Tuolumne.*

Sec. 199. From the county seat of Tuolumne County to Sacramento, one hundred (100) miles; to Napa, one hundred and sixty-one (161) miles; to Stockton, sixty-six (66) miles; to San Quentin, one hundred and sixty-six (166) miles. [Amendment, approved February 15, 1878. Amendments 1877–78, took effect sixtieth day after passage.]

200. *Ventura.*

Sec. 200. From the county seat of Ventura County to Sacramento,

three hundred and ninety-two (392) miles; to Napa, three hundred and forty-seven (347) miles; to Stockton, four hundred (400) miles; to San Quentin, three hundred and twenty (320) miles.

201. *Yolo.*

SEC. 201. From the county seat of Yolo County to Sacramento, twenty (20) miles; to Napa, forty-one (41) miles; to Stockton, sixty-eight (68) miles; to San Quentin, ninety-two (92) miles.

202. *Yuba.*

SEC. 202. From the county seat of Yuba County to Sacramento, fifty-two (52) miles; to Napa, one hundred and thirteen (113) miles; to Stockton, one hundred (100) miles; to San Quentin, one hundred and forty-six (146) miles.

ROUTES OF TRAVEL, MODES OF CONVEYANCE, DISTANCES, ETC., FROM SAN FRANCISCO.

[Compiled from the Railroad Gazetteer.]

ABBREVIATIONS.

a Southern Pacific Company, station foot of Market Street.
b Southern Pacific Company, station Fourth and Townsend Streets.
C. & C.—Carson & Colorado Railroad.
C. N.—California Northern Railroad.
C. S.—California Southern Railroad.
N. C.—Nevada County Narrow Gauge Railroad.
N. & C.—Nevada and California Railroad.
N. P.—Northern Pacific Railroad.
N. P. C.—North Pacific Coast Railroad.
O. & C.—Oregon and California Railroad.
P. C. Ry.—Pacific Coast Railway.
P. M.—Pacific Mail Steamship Company.
P. C.—Pacific Coast Steamship Company.
S. J. & S. N.—San Joaquin and Sierra Nevada Railroad.
S. & P.—Sacramento and Placerville Railroad.
S. F. & N. P.—San Francisco and North Pacific Railroad.
S. P. C.—South Pacific Coast Railroad.
Stmr.—River Steamer.
S. V.—Sonoma Valley Railroad.
U. P.—Union Pacific Railroad.
V. V. & C. L.—Vaca Valley and Clear Lake Railroad.

CALIFORNIA.

Acampo, San Joaquin County.—*a* 107 miles.

Acton, Los Angeles County.—*a* 427 miles.

Adin, Modoc County.—*a* to Redding, 234 miles; stage, 124 miles.

Ætna Hot Springs, Napa County.—*a* to St. Helena, 64 miles; stage, 15 miles.

Agnews, Santa Clara County.—S. P. C., 40 miles.

Alameda, Alameda County.—*a* 11 miles; or S. P. C., 10 miles.

Albion, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 65 miles; or N. P. C. to Duncan Mills, 79 miles; stage, 89 miles; or P. C.

Alder Point, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 127 miles.

Alderneys, Marin County.—N. P. C., 24 miles.

Alder Creek, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 19 miles.

Alila, Tulare County.—*a* 274 miles.

Alleghany, Sierra County.—*a* to Marysville, 142 miles; stage, 60 miles; or *a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 40 miles.

Allens, Shasta County.—*a* to Redding, 234 miles; stage, 22 miles.

Allens Springs, Lake County.—*a* to Williams, 125 miles; stage, 42 miles.

Alma, Santa Clara County.—S. P. C., 58 miles; or *b* to Santa Clara, 47 miles; S. P. C., 15 miles.

Alpine, Los Angeles County.—*a* 417 miles.

Altamont, Alameda County.—*a* 56 miles.

Alta, Placer County.—*a* 158 miles.

Altaville, Calaveras County.—*a* to Milton, 122 miles; stage, 22 miles.

Alturas (Dorris Bridge), Modoc County.—*a* to Redding, 234 miles; stage, 165 miles.

Alvarado, Alameda County.—S. P. C., 24 miles.

Alviso, Santa Clara County.—S. P. C., 38 miles.

Alvord, Inyo County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C., 239 miles.
Amador City, Amador County.—*a* to Ione, 140 miles; stage, 14 miles.
Amboy, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 156 miles.
Anaheim, Los Angeles County.—*a* 509 miles, or P. C. to Anaheim Landing, 396 miles; stage, 13 miles.
Anderson, Shasta County.—*a* 223 miles.
Anderson Springs, Lake County.—*a* to Calistoga, 73 miles; stage, 18 miles, to Middleton; private conveyance, 3 miles.
Angels, Calaveras County.—*a* to Milton, 122 miles; stage, 24 miles.
Anita, Butte County.—*a* 195 miles.
Antelope, Sacramento County.—*a* 104 miles.
Antioch, Contra Costa County.—*a* 54 miles.
Applegate, Placer County.—*a* 136 miles.
Aptos, Santa Cruz County.—*b* 112 miles, or P. C.
Arbuckle, Colusa County.—*a* 114 miles.
Arcade, Sacramento County.—*a* 98 miles.
Arcata, Humboldt County.—P. C. to Eureka, 216 miles; stage, 12 miles.
Arena, Merced County.—*a* 140 miles.
Arroyo Grande, San Luis Obispo County.—*b* to Soledad, 143 miles; stage to San Luis Obispo, 114 miles, P. C. Ry., 15 miles; or P. C. to Port Harford, 201 miles, and P. C. Ry., 25 miles.
Ash Hill, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 131 miles.
Asti, Sonoma County.—S. F. & N. P., 80 miles.
Athlone, Merced County.—*a* 162 miles.
Atwater, Merced County.—*a* 144 miles.
Auburn, Placer County.—*a* 126 miles.
Avon, Contra Costa County.—*a* 39 miles.

Bakersfield, Kern County.—*a* to Sumner, 314 miles; stage, 1 mile.
Ballards, Santa Barbara County.—P. C. to Santa Barbara, 288 miles; stage, 43 miles; or P. C. to Port Harford, 201 miles; P. C. Ry. to Los Alamos, 64 miles; stage, 12 miles.
Baden, San Mateo County.—*b* 12 miles.
Bagdad, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 149 miles.
Bale, Napa County.—*a* 68 miles.
Balena, San Diego County.—*a* to Colton, 540 miles; C. S. to San Diego, 121 miles; stage, 43 miles; or P. C. to San Diego, 482 miles; stage, 43 miles.
Ballona, Los Angeles County.—*a* 493 miles.
Bangor, Butte County.—*a* to Marysville, 142 miles; stage, 20 miles.
Banner, San Diego County.—*a* to Colton, 540 miles; C. S. to San Diego, 121 miles; stage, 50 miles; P. C. to San Diego, 482 miles; stage, 50 miles.
Banning, San Bernardino County.—*a* 569 miles.
Banta, San Joaquin County.—*a* 75 miles.
Bartlett Springs, Lake County.—*a* to Calistoga, 73 miles; stage via Lakeport, 70 miles; or *a* to Williams, 125 miles; stage, 45 miles; or S. F. & N. P. to Cloverdale, 84 miles; stage, 66 miles.
Barretts, Contra Costa County.—*a* 16 miles.
Barro, Napa County.—*a* 66 miles.
Batavia, Solano County.—*a* 65 miles.
Bay Point, Contra Costa County.—*a* 42 miles.
Bealville, Kern County.—*a* 342 miles.

Belmont, San Mateo County.—*b* 25 miles.

Bello, Napa County.—*a* 62 miles.

Bells Springs, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 102 miles.

Benicia, Solano County.—*a* 33 miles.

Benton, Mono County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C. 193 miles.

Berenda, Fresno County.—*a* 178 miles.

Berkeley, Alameda County.—*a* 12 miles.

Berlin, Colusa County.—*a* 119 miles.

Berry Creek, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 16 miles.

Bethany, San Joaquin County.—*a* 77 miles.

Bidwells Bar, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 9 miles.

Bieber, Lassen County.—*a* to Delta, 272 miles; stage, 70 miles.

Big Meadows, Plumas County.—*a* to Chico, 186 miles; stage, 65 miles.

Big Oak Flat, Tuolumne County.—*a* to Milton, 122 miles; stage, 44 miles.

Big Trees, Calaveras County.—*a* to Milton, 122 miles; stage, 47 miles.

Big Trees, Santa Cruz County.—S. P. C., 74 miles.

Big Trees, Mariposa County.—*a* to Raymond, 200 miles; stage, 40 miles.

Biggs Station, Butte County.—*a* 163 miles.

Big Valley, Lassen County.—*a* to Chico, 186 miles; stage, 80 miles.

Binghampton, Solano County.—*a* to Dixon, 68 miles; stage, 7 miles.

Birchville, Nevada County.—*a* to Marysville, 142 miles; stage, 36 miles.

Bishop Creek, Inyo County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C., 224 miles.

Blacks, Yolo County.—*a* 97 miles.

Black Diamond, Contra Costa County.—*a* to Cornwall, 50 miles; Black Diamond R. R., 1 mile.

Black Point, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 36 miles.

Blithedale, Marin County.—N. P. C., 10 miles.

Blocksburg, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 138 miles.

Bloomfield, Sonoma County.—N. P. C. to Valley Ford, 61 miles; stage, 4 miles.

Blue Cañon, Placer County.—*a* 168 miles.

Blue Tent, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 6 miles.

Boca, Nevada County.—*a* 218 miles.

Bodega Roads, Sonoma County.—N. P. C. 64 miles.

Bodie, Mono County.—*a* to Reno, 245 miles; V. & T. to Mound House, 41 miles; C. and C. to Hawthorne, 100 miles; stage, 40 miles.

Bolinas, Marin County.—N. P. C. to San Rafael, 18 miles; stage, 18 miles.

Bolsa, San Benito County.—*a* 89 miles.

Boonville, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 30 miles.

Borden, Fresno County.—*a* 188 miles.

Boulder Creek, Santa Cruz County.—S. P. C. 81 miles.

Bowen's Landing, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 47 miles.

Brentwood, Contra Costa County.—*a* 63 miles.

Bridgeport, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 72 miles.

Bridgeport, Mono County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C. to Hawthorne, 100 miles; stage, 62 miles.

Brighton, Sacramento County.—*a* 134 miles.

Bristol, San Bernardino County.—*a* to Mojave, 382 miles; A. & P. 163 miles.

Bronco, Nevada County.—*a* 223 miles.

Brown's Valley, Yuba County.—*a* to Marysville, 142 miles; stage, 12 miles.

Brownsville, Yuba County.—*a* to Marysville, 142 miles; stage, 33 miles.

Brooklyn, Alameda County.—*a* 9 miles.

Brookside, San Bernardino County.—*a* 547 miles.

Brush Creek, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 25 miles.

Buckeye, Tehama County.—*a* 214 miles.

Buck's Ranch, Plumas County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 44 miles.

Buena Vista, Nevada County.—*a* to Colfax, 144 miles; N. C. 10 miles.

Burson, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. 24 miles.

Burgettsville, Shasta County.—*a* to Redding, 234 miles; stage, 80 miles.

Burdells, Sonoma County.—S. F. & N. P. 29 miles.

Burnetts, Stanislaus County.—*a* 124 miles.

Burney Valley, Shasta County.—*a* to Redding, 234 miles; stage, 64 miles.

Byron, Contra Costa County.—*a* 68 miles.

Byron Hot Springs, Contra Costa County.—*a* to Byron, 68 miles; stage, 2 miles.

Cabazon, San Bernardino County.—*a* 575 miles.

Cactus, San Diego County.—*a* 708 miles.

Cadiz, San Bernardino County.—*a* to Mojave, 382 miles; A. & P. 171 miles.

Cahto, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 74 miles.

Caliente, Kern County.—*a* 336 miles.

Calistoga, Napa County.—*a* 73 miles.

Callahans, Siskiyou County.—*a* to Delta, 272 miles; stage, 45 miles.

Calpella, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 34 miles.

Cambria, San Luis Obispo County.—P. C. to San Simeon, 160 miles; stage, 8 miles.

Cameron, Kern County.—*a* 371 miles.

Camp Bidwell, Modoc County.—*a* to Reno, 244 miles; N. & C. to Moran, 39 miles; stage, 245 miles.

Campbells, Santa Clara County.—S. P. C. 51 miles.

Camp Capitola, Santa Cruz County.—*b* to Soquel (Camp Capitola), 116 miles, or S. P. C. to Santa Cruz, 80 miles; stage, 5 miles.

Camp Taylor, Marin County.—N. P. C., 30 miles.

Campo, San Diego County.—*a* to Colton, 540 miles; C. S. to San Diego, 121 miles; stage, 60 miles; or P. C. to San Diego, 480 miles; stage, 60 miles.

Campo Seco, Calaveras County.—*a* to Lodi, 104 miles; S. J. and S. N. to Valley Spring, 28 miles; stage, 2 miles.

Camptonville, Nevada County.—*a* to Marysville, 142 miles; stage, 43 miles; or *a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 22 miles.

Cana, Butte County.—*a* 198 miles.

Carbondale, Amador County.—*a* 133 miles.
Cannon, Solano County.—*a* 56 miles.
Carnadero, San Benito County.—*b* 82 miles.
Carpenteria, Santa Barbara County.—*a* to Newhall, 452 miles, and stage; or P. C. to Santa Barbara, 288 miles; stage, 8 miles.
Cascade, Nevada County.—*a* 189 miles.
Cape Horn, Placer County.—*a* 148 miles.
Caspar, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 101 miles, or P. C.
Castle Rock, Shasta County.—*a* to Delta, 272 miles; stage, 27 miles.
Castroville, Monterey County.—*b* 110 miles.
Castle, San Joaquin County.—*a* 98 miles.
Cave City, Calaveras County.—*a* to Milton, 122 miles; stage, 32 miles; or *a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage, 22 miles.
Ceres, Stanislaus County.—*a* 119 miles.
Cerro Gordo, Inyo County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C. to Hawley, 293 miles; stage, 6 miles.
Cerritos, Los Angeles County.—*a* 498 miles.
Charleston, San Joaquin County.—*a* 98 miles.
Cherokee Flat, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 12 miles.
Cherokee (Patterson), Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 12 miles.
Chico, Butte County.—*a* 186 miles.
Chili Bar, El Dorado County.—*a* 90 miles to Sacramento; S. & P. to Shingle Springs, 48 miles; stage, 14 miles.
China Ranch, Placer County.—*a* 166 miles.
Chinese Camp, Tuolumne County.—*a* to Milton, 122 miles; stage, 26 miles.
Chinns, Placer County.—*a* 173 miles.
Christine, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 30 miles.
Chualar, Monterey County.—*b* 128 miles; or P. C. S.
Cicero, Sacramento County.—*a* 121 miles.
Cienega, Los Angeles County.—*a* 490 miles.
Cisco, Placer County.—*a* 182 miles.
Clairville, Sonoma County.—S. F. & N. P., 74 miles.
Clarks Summit, Marin County.—N. P. C., 59 miles.
Clay, Sacramento County.—*a* 124 miles.
Clear Creek, Shasta County.—*a* 229 miles.
Clements, San Joaquin County.—*a* to Lodi, 104 miles; S. J. & S. N., 12 miles.
Clinton, Nevada County.—*a* 220 miles.
Clipper Mills, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 30 miles.
Clipper Gap, Placer County.—*a* 133 miles.
Clyde, San Joaquin County.—*a* 119 miles.
Cloverdale, Sonoma County.—S. F. & N. P., 84 miles.
Coles, Siskiyou County.—*a* to Delta, 272 miles; stage, 100 miles.
Colfax, Placer County.—*a* 144 miles.
Collinsville, Solano County.—Stmr., 40 miles.
Coloma, El Dorado County.—*a* to Auburn, 126 miles; stage, 20 miles.
Colma, San Mateo County.—*b* 9 miles.
Colton, San Bernardino County.—*a* 540 miles.

Columbia, Tuolumne County.—*a* to Milton, 122 miles; stage, 49 miles.

Columbia Hill, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 12 miles; or *a* to Marysville, 142 miles; stage, 47 miles.

Colusa, Colusa County.—*a* to Colusa Junction, 129 miles; Colusa R. R., 10 miles.

Comanche, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Wallace, 18 miles; stage, 3 miles.

Cometa, San Joaquin County.—*a* 117 miles.

Compton, Los Angeles County.—*a* 494 miles.

Copper City, Shasta County.—*a* to Redding, 234 miles; stage, 25 miles.

Copperopolis, Calaveras County.—*a* to Milton, 122 miles; stage, 13 miles.

Cordelia, Solano County.—*a* 46 miles.

Cordero, San Diego County.—*a* to Colton, 540 miles; C. S., 101 miles.

Corning, Tehama County.—*a* 179 miles.

Cornwall, Contra Costa County.—*a* 50 miles.

Corralitos, Santa Cruz County.—*b* to Watsonville, 101 miles; stage, 7 miles.

Corte Madera, Marin County.—N. P. C., 12 miles.

Costa, Los Angeles County.—*a* 505 miles.

Cotate Ranch, Sonoma County.—S. F. & N. P., 46 miles.

Cothrins, El Dorado County.—*a* to Sacramento, 90 miles; S. & P., 34 miles.

Cottonwood, Shasta County.—*a* 216 miles.

Cuba, Nevada County.—*a* 222 miles.

Coulterville, Mariposa County.—*a* to Merced, 152 miles; stage, 46 miles.

Courtland, Sacramento County.—Stmr., 95 miles.

Covello, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Ukiah, 30 miles; stage, 65 miles.

Coyote, Santa Clara County.—*b* 63 miles.

Crescent City, Del Norte County.—Steamer Crescent City, every ten days; 274 miles.

Cayucos, San Luis Obispo County.—P. C. 180 miles.

Cedarville, Modoc County.—*a* to Reno, 244 miles; N. & C. to Moran, 30 miles; stage, 186 miles.

Centerville, Alameda County.—S. P. C. to Newark, 29 miles; horse-car, 3 miles; or *a* to Niles, 30 miles; stage, 3 miles.

Crescent Mills, Plumas County.—*a* to Chico, 186 miles; stage, 64 miles; or *b* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 81 miles.

Cross Creek, Tulare County.—*a* 235 miles.

Crystal Springs, San Mateo County.—*b* to San Mateo, 21 miles; stage, 4 miles.

Cucamonga, San Bernardino County.— *a* 524 miles.

Cuffey's Cove, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 80 miles. or P. C., 112 miles.

Cummings, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 90 miles.

Daggett, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 80 miles.

Danby, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 183 miles.

Darwin, Inyo County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C. to Hawley, 293 miles; stage, 22 miles.

Davenport's Landing, Santa Cruz County.—*b* to San Mateo, 21 miles; stage, 57 miles; or S. P. C. to Santa Cruz, 81 miles; stage, 14 miles.

Davis, Yolo County.—*a* 77 miles.

Dayton, Butte County.—*a* to Chico, 186 miles; stage, 6 miles.

Deadwood, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 21 miles.

Decoto, Alameda County.—*a* 27 miles.

De Luz, San Diego County.—*a* to Colton, 540 miles; C. S., 66 miles.

Delano, Kern County.—*a* 282 miles.

Delavan, Colusa County.—*a*, 139 miles.

Delhi, Merced County.—*a*, 133 miles.

Delta, Shasta County.—*a*, 272 miles.

Denverton, Solano County.—Steamer to Rio Vista, 89 miles; stage, 14 miles; or *a* to Suisun, 49 miles; stage, 9 miles.

Diamond Springs, El Dorado County.—*a* 90 miles to Sacramento; S. & P. to Shingle Springs, 48 miles; stage, 7 miles.

Dixon, Solano County.—*a* 68 miles.

Dogtown, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 32 miles.

Dominguez, Los Angeles County.—*a* 496 miles.

Donahue, Sonoma County.—S. F. & N. P., 36 miles.

Donner Lake, Nevada County.—*a* to Summit, 195 miles; stage, 2 miles.

Dougherty's, Santa Cruz County.—S. P. C., 70 miles.

Downey, Los Angeles County.—*a* 495 miles.

Downieville, Sierra County.—*a* to Marysville, 142 miles; stage, 67 miles; or *a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 42 miles.

Drytown, Amador County.—*a* to Ione, 140 miles; stage, 16 miles.

Dugan's, El Dorado County.—*a* to Sacramento, 90 miles; S. & P., 42 miles.

Dry Camp, San Diego County.—*a* 602 miles.

Duncan Mills, Sonoma County.—N. P. C., 79 miles.

Dunnigan, Yolo County.—*a* 104 miles.

Durham, Butte County.—*a* 180 miles.

Dutch Flat, Placer County.—*a* 157 miles.

East Oakland, Alameda County.—*a* 9 miles.

Eden Vale, Santa Clara County.—*b* 57 miles.

Eden Valley, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Ukiah, 30 miles; stage, 45 miles.

Edson, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 192 miles.

El Dorado, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage; 20 miles.

El Casco, San Bernardino County.—*a* 554 miles.

El Rio, San Diego County.—*a* 725 miles.

Elk Grove, Sacramento County.—*a* 124 miles.

Ellis, San Joaquin County.—*a* 70 miles.

Elmira, Solano County.—*a* 60 miles.

Elsinore, San Diego County.—*a* to Colton, 540 miles; C. S. 34 miles.

Ely's, Sonoma County.—S. F. & N. P., 30 miles.

Emigrant Gap, Placer County.—*a* 173 miles.

Emmaton, Sacramento County.—Steamer, 56 miles.

Encinitas, San Diego County.—*a* to Colton, 540 miles; C. S. 92 miles.

Eperson, Colusa County.—*a* to Williams, 125 miles; stage, 26 miles.

Eureka, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Hydesville, 182 miles; E. R. & E. R. R. to Eureka, 24 miles; or P. C., 216 miles.

Ewing, Placer County.—*a* 123 miles.

Fairfax, Marin County.—N. P. C., 17 miles.
Fair Oaks, San Mateo County.—*b* 31 miles.
Fall City, Shasta County.—*a* to Redding, 234 miles; stage, 80 miles.
Fallbrook, San Diego County.—*a* to Colton, 540 miles; C. S., 60 miles.
Farmington, San Joaquin County.—*a* 111 miles.
Felton, Santa Cruz County.—S. P. C., 73 miles; or *b* to Santa Cruz, 121 miles; S. P. C., 7 miles.
Fenner, San Bernardino County.—*a* to Mojave, 382 miles; A. & P. 199 miles.
Ferndale, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Eureka, 210 miles; stage, 17 miles; or P. C. S.
Ferndale, Alameda County.—*a* 12 miles.
Fiddletown, Amador County.—*a* to Ione, 140 miles; stage, 22 miles.
Field's Landing, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Hydesville, 182 miles; E. R. & E. R. R. to Field's Landing, — miles.
Finnell, Tehama County.—*a* 185 miles.
Firebaugh's, Fresno County.—*a* to Madera, 185 miles; stage, 20 miles.
Fish Rock, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 50 miles.
Fisherman's, Marin County.—N. P. C., 45 miles.
Fisherman's Bay, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 33 miles.
Fisk's Mills, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 30 miles.
Florin, Sacramento County.—*a* 130 miles.
Florence, Los Angeles County.—*a* 488 miles.
Folsom, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 22 miles.
Flowing Well, San Diego County.—*a* 671 miles.
Forbestown, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 22 miles.
Forest City, Sierra County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 40 miles; or *a* to Marysville, 142 miles; stage, 60 miles.
Forest Hill, Placer County.—*a* to Auburn, 126 miles; stage, 22 miles.
Forest Home, Amador County.—*a* to Ione, 140 miles; stage, 4 miles.
Forestville, Sonoma County.—S. F. & N. P., 64 miles.
Fort Jones, Siskiyou County.—*a* to Delta, 272 miles; stage, 107 miles.
Fort Ross, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 17 miles.
Fort Yuma, San Diego County.—*a* 729 miles.
Fowler, Fresno County.—*a* 216 miles.
Fraziers, San Diego County.—*a* to Colton, 540 miles; C. S., 83 miles.
Freeport, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 7 miles.
Freestone, Sonoma County.—N. P. C., 65 miles.
French Camp, San Joaquin County.—*a* 87 miles.
French Corral, Nevada County.—*a* to Marysville, 142 miles; stage, 33 miles.
Fresno, Fresno County.—*a* 207 miles.
Frinks, San Diego County.—*a* 653 miles.
Fruitvale, Alameda County.—*a* 10 miles.
Fulton, Sonoma County.—S. F. & N. P., 56 miles.

Gabilan, Monterey County.—*b* to Salinas, 118 miles; stage, 10 miles.

Galt, Sacramento County.—*a* 113 miles.

Garcia, Marin County.—N. P. C., 34 miles.

Garden Valley, El Dorado County.—*a* to Auburn, 126 miles; stage, 25 miles.

Garrotte, Tuolumne County.—*a* to Milton, 122 miles; stage, 37 miles.

Gaviota, Santa Barbara County.—P. C., 260 miles.

Germantown, Colusa County.—*a* 158 miles.

Georgetown, El Dorado County.—*a* to Auburn, 126 miles; stage, 22 miles.

Geyser Springs, Sonoma County.—*a* to Calistoga, 73 miles; stage, 27 miles; or S. F. & N. P. to Cloverdale, 84 miles; stage, 15 miles.

Gibsonville, Sierra County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 28 miles.

Gilroy, Santa Clara County.—*b* 80 miles.

Gilroy Hot Springs, Santa Clara County.—*b* to Gilroy, 80 miles; stage, 10 miles.

Girard, Kern County.—*a* 355 miles.

Glenbrook, Lake County.—*a* to Calistoga, 73 miles; stage, 29 miles.

Glencoe, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Springs, 28 miles; stage, 20 miles.

Glendale, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 12 miles.

Glen Ellen, Sonoma County.—S. V., 44 miles.

Glenwood, Santa Cruz County.—S. P. C., 66 miles.

Gloster, Kern County.—*a* 388 miles.

Goffs, San Bernardino County.—*a* to Mojave, 382 miles; A. & P. 209 miles.

Gold Run, Placer County.—*a* 154 miles.

Gonzales, Monterey County.—*b* 134 miles.

Goodwins, Sonoma County.—S. F. & N. P., 41 miles.

Goodyears, Solano County.—*a* 39 miles.

Goshen, Tulare County.—*a* 241 miles.

Graciosa, Santa Barbara County.—P. C. to Port Harford, 201 miles; P. C. R., 49 miles.

Grand Island, Colusa County.—*a* to Knight's Landing, 95 miles; stmr., 36 miles.

Granite Hill, El Dorado County.—*a* to Auburn, 126 miles; stage, — miles.

Graniteville (Eureka South), Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 27 miles.

Grant's Station, Sonoma County.—S. F. & N. P., 64 miles.

Green Brae, Marin County.—S. F. & N. P., 13 miles.

Grass Valley, Nevada County.—*a* to Colfax, 144 miles; N. C., 17 miles.

Green Valley, Sonoma County.—S. F. & N. P., 66 miles.

Greenville, Plumas County.—*a* to Chico, 186 miles; stage, 60 miles; or *a* to Reno, 244 miles; N. & C. to Moran, 39 miles; stage, 24 miles.

Greenwood, Colusa County.—*a* 163 miles.

Greenwood, El Dorado County.—*a* to Auburn, 126 miles; stage, 4 miles.

Gridley, Butte County.—*a* 160 miles.

Griffins, Marin County.—N. P. C., 57 miles.

Guadalupe, Santa Barbara County.—P. C. to Port Harford, 201 miles; P. C. Ry. and stage, 24 miles.

Gualala, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 45 miles.
Guerneville, Sonoma County.—S. F. & N. P., 72 miles.

Halls, Alameda County.—S. P. C., 25 miles.
Hamlet, Marin County.—N. P. C., 51 miles.
Hanford, Tulare County.—*a* 254 miles.
Hangtown Crossing, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 12 miles.
Harper, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 51 miles.
Harrington, Colusa County.—*a* 109 miles.
Harbin Springs, Lake County.—*a* to Calistoga, 73 miles; stage, 21 miles.
Havilah, Kern County.—*a* to Caliente, 336 miles; stage, 28 miles.
Hawley, Inyo County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C., 293 miles.
Haslett, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 105 miles.
Haywards, Alameda County.—*a* 21 miles.
Healdsburg, Sonoma County.—S. F. & N. P., 66 miles.
Heinlen, Tulare County.—*a* 263 miles.
Henly, Siskiyou County.—*a* to Delta, 272 miles; stage, 94 miles.
Highland, Santa Cruz County.—S. P. C., 64 miles.
Highland Springs, Lake County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 28 miles.
Highland, Alameda County.—*a* 12 miles.
Hilarita, Marin County.—S. F. & N. P., 7 miles.
Hinckley, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 61 miles.
Holden, San Joaquin County.—*a* 103 miles.
Hollister, San Benito County.—*b* 94 miles.
Honcut, Butte County.—*a* to Marysville, 142 miles; C. N., 12 miles.
Homer, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 217 miles.
Homestead, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 3 miles.
Hooker, Tehama County.—*a* 209 miles.
Hookton, Humboldt County.—P. C., 222 miles.
Hopland, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 16 miles.
Hornitos, Mariposa County.—*a* to Merced, 152 miles; stage, 22 miles.
Hotel de Redwood, Santa Cruz County.—S. P. C. to Wrights, 62 miles; stage, 4 miles.
Hotel del Monte, Monterey County.—(See Monterey.)
Houghs Mineral Springs, Lake County.—*a* to Williams, 125 miles; stage, 38 miles.
Howards, Sonoma County.—N. P. C., 69 miles.
Howland Flat, Sierra County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 55 miles.
Hueneme, Ventura County.—P. C., 321 miles.
Humboldt Bay, Humboldt County.—P. C., 216 miles.
Huron, Tulare County.—*a* 281 miles.
Hydesville, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 182 miles; or P. C. to Eureka, 216 miles; stage, 25 miles.

Ibex, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 226 miles.
Igo, Shasta County.—*a* to Anderson, 223 miles; stage, 14 miles.
Independence, Inyo County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C., 276 miles.
Indio, San Diego County.—*a* 612 miles.
Ingrams, Sonoma County.—N. P. C., 87 miles.
Ione, Amador County.—*a* to Galt, 140 miles.
Iowa Hill, Placer County.—*a* to Colfax, 144 miles; stage, 8 miles.

Jacinto, Colusa County.—*a* to Chico, 186 miles; stage, 15 miles.
Jackson, Amador County.—*a* to Ione, 140 miles; stage, 12 miles.
Jacksonville, Tuolumne County.—*a* to Milton, 122 miles; stage, 29 miles.
Java, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 233 miles.
Jamestown, Tuolumne County.—*a* to Milton, 122 miles; stage, 31 miles.
Janesville, Lassen County.—*a* to Reno, 244 miles; N. & C. to Moran, 39 miles; stage, 41 miles.
Jenny Lind, Calaveras County.—*a* to Milton, 122 miles; stage, 4 miles.
Jewells, Marin County.—N. P. C., 3 1miles.
Jolon, Monterey County.—*b* to Soledad, 143 miles; stage, 42 miles.
Julian, San Diego County.—*a* to Colton, 540 miles; C. S. to San Diego. 121 miles; stage, 65 miles; or P. C. to San Diego, 482 miles; stage, 65 miles.
Junction, Marin County.—S. F. & N. P., 35 miles.
Junction (Roseville), Placer County.—*a* 108 miles.

Keene, Kern County.—*a* 350 miles.
Kent, Los Angeles County.—*a* 444 miles.
Kelsey, El Dorado County.—*a* to Auburn, 126 miles; stage, 28 miles.
Kelseyville, Lake County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 33 miles; or *a* to Calistoga, 73 miles; stage, 40 miles.
Kernville, Kern County.—*a* to Caliente, 336 miles; stage, 40 miles.
Keyes, Stanislaus County.—*a* 122 miles.
Kingsburg, Tulare County.—*a* 227 miles.
Kibbesilla, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 90 miles; or N. P. C. to Duncan Mills, 79 miles; stage, 120 miles.
Kirkwood, Tehama County.—*a* 174 miles.
Klamath Ferry, Siskiyou County.—*a* to Delta, 272 miles; stage, 90 miles.
Knights Ferry, Stanislaus County.—*a* to Oakdale, 126 miles; stage, 12 miles.
Knights Landing, Yolo County.—*a* 95 miles.
Knoxville, Napa County.—*a* to Calistoga, 73 miles; stage, 28 miles.
Korbells, Sonoma County.—S. F. & N. P., 69 miles.
Kramer, Kern County.—*a* to Mojave, 382 miles; A. & P., 38 miles.
Kress Summit, Nevada County.—*a* to Colfax, 144 miles; N. C., 13 miles.

La Graciosa, Santa Barbara County.—P. C.
La Grange, Stanislaus County.—*a* to Modesto, 114 miles; stage, 32 miles.
La Honda, San Mateo County.—*b* to Redwood, 29 miles; stage, 18 miles.
La Porte, Plumas County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 45 miles.
Laguna, Sonoma County.—S. F. & N. P., 62 miles.
Lagunitas, Marin County.—N. P. C., 27 miles.

Lake City (Surprise Valley), Modoc County.—*a* to Reno, 244 miles; stage, 220 miles; or *a* to Redding, 234 miles; stage, 220 miles.

Lake City, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 12 miles.

Lake Tahoe—(see Tahoe City).

Lakeport, Lake County.—*a* to Calistoga, 73 miles; stage, 46 miles; or S. F. & N. P. to Cloverdale, 84 miles; stage, 40 miles.

Lakeville, Sonoma County.—S. F. & N. P., 36 miles.

Lakeview, Modoc County.—*a* to Marysville, 142 miles; stage, 225 miles.

Lancaster, Los Angeles County.—*a* 406 miles.

Lancha Plana, Amador County.—*a* to Lodi, 104 miles; S. J. & S. N. to Wallace, 18 miles; stage, 7 miles.

Lander, Placer County.—*a* 141 miles.

Langville, Yolo County.—*a* to Woodland, 86 miles; stage, 16 miles.

Lang, Los Angeles County.—*a* 439 miles.

Lathrop, San Joaquin County.—*a* 83 miles.

Latrobe, El Dorado County.—*a* to Sacramento, 90 miles; S. & P., 37 miles.

Lawrence, Santa Clara County.—*b* 44 miles.

Laytonville, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 78 miles.

Leesville, Colusa County.—*a* to Williams, 125 miles; stage, 21 miles.

Lemoore, Tulare County.—*a* 262 miles.

Lerdo, Kern County.—*a* 302 miles.

Lexington, Santa Clara County.—S. P. C. to Alma, 58 miles; stage, 7 miles; or *b* to Santa Clara, 47 miles; stage, 15 miles.

Liebigs, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 22 miles.

Lincoln, Placer County.—*a* 119 miles.

Linden, San Joaquin County.—*a* to Stockton, 92 miles; stage, 14 miles.

Little River, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 93 miles; or S. F. & N. P. to Cloverdale, 84 miles; stage, 73 miles, or P. C.

Little York, Nevada County.—*a* to Colfax, 144 miles; N. C., 22 miles; stage, 13 miles.

Litton Springs, Sonoma County.—S. F. & N. P., 70 miles.

Live Oak, Sutter County.—*a* 153 miles.

Livermore, Alameda County.—*a* 48 miles.

Livingston, Merced County.—*a* 137 miles.

Lockeford, San Joaquin County.—*a* to Lodi, 104 miles; S. J. & S. N., 8 miles.

Lodi, San Joaquin County.—*a* 104 miles.

Logandale, Colusa County.—*a* 145 miles.

Lomo, Sutter County.—*a* 149 miles.

Lompoc, Santa Barbara County.—P. C. to Gaviota, 260 miles; stage, 14 miles.

Lompoc, San Luis Obispo County.—P. C. to Port Harford, 201 miles; P. C. Ry. to Los Alamos, 64 miles; stage, 12 miles.

Lone Pine, Inyo County.—*a* to Reno, 244 miles; V. T. to Mound House, 41 miles; C. & C., 281 miles.

Lorenzo, Alameda County.—*a* 18 miles.

Lorenzo, Santa Cruz County.—S. P. C., 80 miles.

Los Alamos, Santa Barbara County.—P. C. to Port Harford, 201 miles; P. C. Ry., 64 miles.

Los Angeles, Los Angeles County.—*a* 482 miles; or P. C. to San Pedro, 389 miles; *a* 25 miles.

Los Banos, Merced County.—*b* to Gilroy, 80 miles; stage, 52 miles.

Los Berros, San Luis Obispo County.—P. C. to Port Harford, 201 miles; P. C. Ry., 30 miles.

Los Flores, San Diego County.—*a* Colton, 540 miles; C. S. to San Diego, 121 miles; stage, 28 miles; or P. C. to San Diego, 482 miles; stage, 28 miles.

Los Gatos, Santa Clara County.—S. P. C., 55 miles.

Los Medanos, Contra Costa County.—*a* 51 miles.

Louisville, El Dorado County.—*a* to Auburn, 126 miles; stage, 29 miles.

Lovejoys, El Dorado County.—*a* to Auburn, 126 miles; stage, 7 miles.

Lovelady, Santa Clara County.—S. P. C., 51 miles.

Lower Lake, Lake County.—*a* to Calistoga, 73 miles; stage, 35 miles.

Lowes, Monterey County.—*b* to Soledad, 143 miles; stage, 28 miles.

Ludlow, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 125 miles.

Lyfords, Marin County.—N. P. C., 10 miles.

Lyman, Colusa County.—*a* 154 miles.

Macy, Colusa County.—*a* 119 miles.

Madison, Yolo County.—*a* to Elmira, 60 miles; V. V. & C. L., 29 miles.

Madera, Fresno County.—*a* 185 miles.

Madrone, Santa Clara County.—*b* 69 miles.

Magnetic Springs.—S. P. C., to Glenwood, 66 miles; stage, 4 miles.

Malaga, Fresno County.—*a* 211 miles.

Malton, Colusa County.—*a* 170 miles.

Mammoth Tank, San Diego County.—*a* 683 miles.

Manchester, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 65 miles, or P. C.

Mariposa, Mariposa County.—*a* to Merced, 152 miles; stage, 41 miles.

Markleeville, Alpine County.—*a* to Reno, 244 miles; V. & T. to Carson, 31 miles; stage, 39 miles.

Mark West, Sonoma County.—S. F. & N. P., 57 miles.

Markhams, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 3 miles.

Marshalls, Marin County.—N. P. C., 47 miles.

Martinez, Contra Costa County.—*a* 36 miles.

Marysville, Yuba County.—*a* 142 miles.

Maxwell, Colusa County.—*a* 134 miles.

Mayfield, Santa Clara County.—*b* 35 miles.

Mayhews, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 10 miles.

McAvoy, Contra Costa County.—*a* 45 miles.

McConnells, Sacramento County.—*a* 120 miles.

Meacham's, Sonoma County.—S. F. & N. P., 58 miles.

Meadow Valley, Plumas County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 53 miles.

Melrose, Alameda County.—*a* 11 miles.

Mendocino, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 8 miles; or S. F. & N. P. to Cloverdale, 84 miles; stage, 75 miles; or P. C., 122 miles.

Menlo Park, San Mateo County.—*b* 32 miles.

Merced, Merced County.—*a* 152 miles.

Merced Falls, Merced County.—*a* to Merced, 152 miles; stage, 22 miles.

Meridian, Sutter County.—*a* to Marysville, 142 miles; stage, 17 miles.

Michigan Bar, Sacramento County.—*a* to Sacramento, 90 miles; S. & P. to Latrobe, 37 miles; stage, 6 miles.

Michigan Bluffs, Placer County.—*a* to Auburn, 126 miles; stage, 30 miles.

Middletown, Lake County.—*a* to Calistoga, 73 miles; stage, 18 miles.

Midway, Alameda County.—*a* 64 miles.

Milford, Lassen County.—*a* to Reno, 244 miles; N. & C. to Moran, 39 miles; stage, 28 miles.

Millbrae, San Mateo County.—*b* 17 miles.

Millerton, Fresno County.—*a* to Borden, 188 miles; stage, 20 miles.

Millerton, Marin County.—N. P. C., 42 miles.

Millers, Marin County.—S. F. & N. P., 20 miles.

Millville, Shasta County.—*a* to Redding, 234 miles; stage, 15 miles.

Milpitas, Santa Clara County.—*a* 42 miles.

Milton, Calaveras County.—*a* 122 miles.

Minturn, Fresno County.—*a* 168 miles.

Mitchel, Alameda County.—*a* 13 miles.

Modesto, Stanislaus County.—*a* 114 miles.

Mojave, Kern County.—*a* 382 miles.

Mokelumne Hill, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage, 12 miles.

Monitor, Alpine County.—*a* to Reno, 244 miles; V. & T. to Carson, 31 miles; stage, 36 miles.

Monte, Los Angeles County.—*a* 495 miles.

Monticello, Napa County.—*a* to Napa, 46 miles; stage, 27 miles.

Monterey, Monterey County.—*b* 125 miles; or P. C., 85 miles.

Montezuma, Tuolumne County.—To Milton, 122 miles; stage, 28 miles.

Moore's Flat, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 20 miles.

Morrano, San Joaquin County.—*a* 100 miles.

Morro, San Luis Obispo County.—P. C., 166 miles.

Moscow Mills, Sonoma County.—N. P. C., 78 miles.

Mosquito Gulch, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage, 17 miles.

Mound City, San Bernardino County.—*a* 543 miles.

Mount Eden, Alameda County.—S. P. C., 20 miles; or *a* to Haywards, 21 miles; stage, 8 miles.

Mountain House, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 24 miles.

Mountain Ranch, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage, 20 miles.

Mountain View, Santa Clara County.—*b* 39 miles.

Mowrys, Alameda County.—S. P. C., 32 miles.

Mud Springs (El Dorado), El Dorado County.—*a* to Sacramento, 90 miles; S. & P. to Shingle Springs, 48 miles; stage, 5 miles.

Murrieta, San Diego County.—*a* to Colton, 540 miles; C. S., 43 miles.

Murphys, Calaveras County.—*a* to Milton, 122 miles; stage, 33 miles.

Mystic, Nevada County.—*a* 227 miles.

Nacimento, Monterey County.—*b* to Soledad, 143 miles; stage to San Miguel, 73 miles.

Nadeau, Kern County.—*a* 376 miles.

Napa, Napa County.—*a* 46 miles.

Napa Junction, Napa County.—*a* 38 miles.

Nashville, El Dorado County.—*a* to Sacramento, 90 miles; S. & P. to Shingle Springs, 48 miles; stage, 4 miles.

National City, San Diego County.—*a* to Colton, 540 miles; C. S., 127 miles, or P. C. S.

Natividad, Monterey County.—*b* to Salinas, 118 miles; stage, 8 miles.

Navarro Ridge, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 63 miles; or N. P. C. to Duncan Mills, 79 miles; stage, 85 miles; or P. C. to Whitesboro.

Nelson, Butte County.—*a* 173 miles.

Nevada, Nevada County.—*a* to Colfax, 144 miles; N. C., 22 miles.

New Hope, San Joaquin County.—*a* to Lodi, 104 miles; stage, 14 miles.

New Idria, Fresno County.—*b* to Tres Pinos, 100 miles; stage, 63 miles.

New York Landing, Contra Costa County.—Stmr., 39 miles.

New Almaden, Santa Clara County.—*b* to San José, 50 miles; stage, 15 miles.

Newark, Alameda County.—S. P. C., 29 miles.

Newcastle, Placer County.—*a* 121 miles.

Newhall, Los Angeles County.—*a* 452 miles.

Newville, Colusa County.—*a* to Williams, 125 miles; stage, 65 miles.

Neylans Mills, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 57 miles.

N. E. Mills, Placer County.—*a* 139 miles.

Nicasio, Marin County.—N. P. C. 25 miles; stage, 3 miles.

Nicolaus, Sutter County.—*a* to Wheatland, 130 miles; stage, 4 miles.

Niles, Alameda County.—*a* 30 miles.

Nipomo, San Luis Obispo County.—*a* P. C. to Port Harford, 201 miles; P. C. Ry., 35 miles.

Nord, Butte County.—*a* 193 miles.

Nordhoff, Ventura County.—P. C. to San Buenaventura, 311 miles; stage, 12 miles; or *a* Newhall, 452 miles; stage, 60 miles.

Norman, Colusa County.—*a* 143 miles.

North Bloomfield, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 15 miles.

North San Juan, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 12 miles; or *a* to Marysville, 142 miles; stage, 45 miles.

Nortonville, Contra Costa County.—*a* to Cornwall, 50 miles; Black Diamond R. R., 6 miles.

Norwalk, Los Angeles County.—*a* 499 miles; or by P. C. to Los Angeles.

Novato, Marin County.—S. F. & N. P., 26 miles.

Noyo, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 83 miles; or N. P. C. to Duncan Mills, 79 miles; stage, 106 miles; or P. C.

Oak Grove, San Mateo County.—*b* 19 miles.

Oak Grove, Sonoma County.—S. F. & N. P., 48½ miles.

Oak Knoll, Napa County.—*a* 51 miles.

Oakdale, Stanislaus County.—*a* 126 miles.

Oakland, Alameda County.—*a* 6 miles; or S. P. C., 8 miles.

Oakville, Napa County.—*a* 58 miles.

Oat Creek, Tehama County.—*a* 192 miles.

Ocean Side, San Diego County.—*a* to Colton, 540 miles; C. S., 80 miles.

Ocean View, San Francisco County.—*b* 7 miles.

Ocean View, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 14 miles.

Ogilby, San Diego County.—*a* 715 miles.

Olema, Marin County.—N. P. C., 38 miles.

Omega, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 20 miles.

Ontario, San Bernardino County.—*a* 521 miles.

Ophir, Placer County.—*a* to Newcastle, 121 miles; stage, 2 miles.

Orange, Los Angeles County.—*a* 514 miles.

Oregon House, Yuba County.—*a* to Marysville, 142 miles; stage, 23 miles.

Orland, Colusa County.—*a* 166 miles.

Oro Fino, Siskiyou County.—*a* to Delta, 272 miles; stage, 65 miles.

Oroville, Butte County.—*a* to Marysville, 142 miles; C. N., 28 miles.

Otay, San Diego County.—*a* via San Diego or P. C.

Pacheco, Contra Costa County.—*a* to Martinez, 36 miles; stage, 5 miles.

Pacific Congress Springs, Santa Clara County.—*b* to Santa Clara, 47 miles; stage, 11 miles; or S. P. C. to Los Gatos, 55 miles; stage, 5 miles.

Pacheco, Marin County.—S. F. & N. P., 23 miles; or N. P. C., 18 miles.

Pages, Sonoma County.—S. F. & N. P., 43 miles.

Pajaro, Santa Clara County.—*b* 99 miles.

Pampa, Kern County.—*a* 329 miles.

Paraiso Springs, Monterey County.—*b* to Soledad, 143 miles; stage, 7 miles.

Paso Robles Hot Springs, San Luis Obispo County.—*b* to Soledad, 143 miles; stage, 78 miles; or P. C. to Port Harford, 201 miles; P. C. Ry. to San Luis Obispo, 11 miles; stage, 30 miles.

Patchin, Santa Clara County.—*b* to Santa Clara, 47 miles; stage; or S. P. C. to Alma, 45 miles; stage.

Pasadena, Los Angeles County.—*a* to Los Angeles, 482 miles; Los Angeles and San Gabriel Valley R. R., 10 miles.

Pearsons Springs, Lake County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 46 miles.

Penns Grove, Sonoma County.—S. F. & N. P., 40 miles.

Penyrn, Placer County.—*a* 118 miles.

Pentz, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 12 miles.

Perkins, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 7 miles.

Perrys, Santa Cruz County.—*b* 66 miles.

Pescadero, San Mateo County.—*b* to San Mateo, 21 miles; stage, 32 miles; or *b* to Redwood, 29 miles; stage, 35 miles.

Petaluma, Sonoma County.—S. F. & N. P., 36 miles.

Peters, San Joaquin County.—*a* 107 miles.

Petrolia, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Eureka, 210 miles; stage, 50 miles; or P. C. to Eureka.

Pino, Placer County.—*a* 115 miles.

Pigeon Point, San Mateo County.—*b* to San Mateo, 21 miles; stage, 39 miles.

Pike City, Sierra County.—*a* to Marysville, 142 miles; stage, 50 miles; or *a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 27 miles.

Pilot Hill, El Dorado County.—*a* to Auburn, 126 miles; stage, 8 miles.

Pilot Knob, San Diego County.—*a* 721 miles.

Pinacate, San Diego County.—*a* to Colton, 540 miles; C. S., 22 miles.

Pine Flat, Sonoma County.—*a* to Calistoga, 73 miles; stage, 18 miles.

Pinole, Contra Costa County.—*a* 24 miles.

Platts Mill, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 30 miles.

Placerville, El Dorado County.—*a* to Sacramento, 90 miles; S. & P. to Shingle Springs, 48 miles; stage, 10 miles.

Pleasanton, Alameda County.—*a* 42 miles.

Pleasant Valley, El Dorado County.—*a* to Sacramento, 90 miles; S. & P. to Shingle Springs, 48 miles; stage, 21 miles.

Pleito, Monterey County.—*b* to Soledad, 143 miles; stage, 54 miles.

Plymouth, Amador County.—*a* to Ione, 140 miles; stage, 18 miles.

Point Arena, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 60 miles; or P. C., 100 miles.

Point Reyes (Olema), Marin County.—N. P. C., 38 miles.

Point Tiburon, Marin County.—S. F. &. N. P., 6 miles.

Pomona, Los Angeles County.—*a* 515 miles.

Port Costa, Contra Costa County.—*a* 32 miles.

Port Harford, San Luis Obispo County.—P. C. S., 201 miles.

Poso, Kern County.—*a* 294 miles.

Potter Valley, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 48 miles.

Poway, San Diego County.—P. C. to San Diego, 482 miles; stage, 22 miles; or *a* to Colton, 540 miles; C. S. to San Diego, 121 miles; stage, 22 miles.

Prairie, Yolo County.—*a* to Blacks, 97 miles; stage, 2 miles.

Prattville, Plumas County.—*a* to Chico, 186 miles; stage, 40 miles.

Princeton, Colusa County.—*a* to Norman, 143 miles; stage, 10 miles.

Proctors, Nevada County.—*a* 212 miles.

Prosser, Nevada County.—*a* 216 miles.

Puente, Los Angeles County.—*a* 501 miles.

Purissima, San Mateo County.—*b* to San Mateo, 21 miles; stage, 18 miles.

Quaker Hill, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 7 miles.

Quincy, Plumas County.—*a* to Reno, 244 miles; N. & C. to Moran, 39 miles; stage, 60 miles.

Railroad Flat, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage, 25 miles.

Ravena, Los Angeles County.—*a* 431 miles.

Rawson, Tehama County.—*a* 194 miles.

Raymond, Fresno County.—*a* 200 miles.

Redding, Shasta County.—*a* 234 miles.

Red Bluff, Tehama County.—*a* 199 miles.

Reeds, Yuba County.—*a* 136 miles.

Reeds, Marin County.—S. F. & N. P., 10 miles.

Redwood City, San Mateo County.—*b* 29 miles.

Reynolds Ferry, Calaveras County.—*a* to Milton, 122 miles; stage, 20 miles.

Rich Bar, Plumas County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage to Spanish Ranch, 57 miles; saddle train, 12 miles.

Richfield, Tehama County.—*a* 183 miles.

Ridgeville, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 160 miles.

Rincon, Santa Cruz County.—S. P. C., 77 miles.

Rio Vista, Solano County.—Stmr., 89 miles.

Ripon, San Joaquin County.—*a* 105 miles.

Riverside, San Bernardino County.—*a* to Colton, 540 miles; C. S., 5 miles.

Rocklin, Placer County.—*a* 112 miles.

Rhonerville, Humboldt County.—P. C. to Eureka, 216 miles; stage, 20 miles; or S. F. & N. P. to Cloverdale, 84 miles; stage to Hydesville, 182 miles; E. R. & E. R. R. to Rhonerville.

Roseville (Junction), Placer County.—*a* 108 miles.

Ross Station, Marin County.—N. P. C., 15 miles.

Rules Landing, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 8 miles.

Rough and Ready, Nevada County.—*a* to Colfax, 144 miles; N. C. to Grass Valley, 17 miles; stage, 4 miles.

Routiers, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 12 miles.

Russells, Alameda County.—S. P. C., 19 miles.

Russian River, Sonoma County.—N. P. C., 75 miles.

Rutherford, Napa County.—*a* 60 miles.

Sacramento, Sacramento County.—*a* via Benicia, 90 miles; or Stmr., 120 miles.

Sacramento Ferry, Shasta County.—*a* to Redding, 234 miles; stage, 32 miles.

Salida, Stanislaus County.—*a* 108 miles.

Salinas, Monterey County.—*b* 118 miles; or P. C. S.

Salmon Falls, El Dorado County.—*a* to Sacramento, 90 miles; S. & P. to Folsom, 22 miles; stage, 9 miles.

Salsbury, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 16 miles.

Salmon Creek, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Hydesville, 182 miles; E. R. & E. R. R. to Salmon Creek.

Sand Cut, Monterey County.—*b* 94 miles.

Salt Point, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 25 miles.

San Andreas, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Springs, 28 miles; stage, 10 miles.

San Anselmo, Marin County.—N. P. C., 16 miles.

San Antonio, Monterey County.—*b* to Soledad, 143 miles; stage, 30 miles.

San Benito, San Benito County.—*b* to Tres Pinos, 101 miles; stage, 28 miles.

San Bernardino, San Bernardino County.—*a* to Colton, 540 miles; C. S., 3 miles.

San Bruno, San Mateo County.—*b* 14 miles.

San Buenaventura, Ventura County.—P. C., 311 miles; or *a* to Newhall, 452 miles; stage, 50 miles.

San Clemente, Marin County.—S. F. & N. P., 10 miles.

San Diego, San Diego County.—*a* to Colton, 540 miles; C. S., 121 miles; or P. C., 482 miles.

San Fernando, Los Angeles County.—*a* 461 miles.

San Dieguito, San Diego County.—*a* to Colton, 450 miles; C. S. to San Diego, 121 miles; stage, 23 miles; or P. C.

San Felipe, Santa Clara County.—*b* to Gilroy, 80 miles; stage, 10 miles.

San Gabriel, Los Angeles County.—*a* 491 miles.

San Geronimo, Marin County.—N. P. C., 24 miles.

San Gorgonio, San Bernardino County.—*a* 563 miles.

San Gregorio, San Mateo County.—*b* to San Mateo, 21 miles; stage, 26 miles; or *b* to Redwood, 29 miles; stage, 26 miles.

San José, Santa Clara County.—S. P. C., 46 miles; or *b* 50 miles; or *a* 47 miles.

San Juan, San Benito County.—*b* to Sargent's, 86 miles; stage, 6 miles.

San Juan Capistrano, Los Angeles County.—*a* to Santa Ana, 516 miles; stage, 28 miles; or P. C.

San Leandro, Alameda County.—*a* 16 miles; or S. P. C., 14 miles.

San Lorenzo, Alameda County.—S. P. C., 17 miles.

San Luis Obispo, San Luis Obispo County.—*b* to Soledad, 143 miles; stage, 114 miles; or P. C. to Port Harford, 201 miles; P. C. Ry., 11 miles.

San Luis Ranch, Merced County.—*b* to Gilroy, 80 miles; stage, 42 miles.

San Luis Rey, San Diego County.—*a* to Santa Ana, 516 miles; stage, 59 miles; or by P. C. to San Diego, 482 miles; stage, 45 miles.

San Marcos, Santa Barbara County.—*b* to Soledad, 143 miles; stage, 190 miles; or P. C. to Port Harford, 201 miles; stage, 24 miles.

San Mateo, San Mateo County.—*b* 21 miles.

San Miguel, San Luis Obispo County.—*b* to Soledad, 143 miles; stage, 78 miles; or P. C.

San Pablo, Contra Costa County.—*a* 18 miles.

San Pasqual, San Diego County.—*a* to Santa Ana, 516 miles; stage, 59 miles; or P. C. to San Diego, 482 miles; stage, 45 miles.

San Pedro, Los Angeles County.—P. C., 387 miles; or *a* 507 miles.

San Quentin, Marin County.—N. P. C., 21 miles.

San Rafael, Marin County.—N. P. C., 18 miles; or S. F. & N. P., 15 miles.

San Ramon, Contra Costa County.—*a* to Oakland, 7 miles; stage, 14 miles.

San Simeon, San Luis Obispo County.—P. C., 160 miles.

San Ysidro, Santa Clara County.—*b* to Gilroy, 80 miles; stage, 3 miles.

Sanel, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 17 miles.

Santa Ana, Los Angeles County.—*a* 516 miles.

Santa Anita, Los Angeles County, 16 miles from Los Angeles via L. A. & S. G. V. R. R.

Santa Barbara, Santa Barbara County.—P. C., 288 miles; or *a* to Newhall, 452 miles; stage, 80 miles; or *b* to Soledad, 143 miles; stage, 260 miles.

Santa Clara, Santa Clara County.—*b* 47 miles; or S. P. C., 44 miles.

Santa Cruz, Santa Cruz County.—S. P. C., 81 miles; or *b* 121 miles; or P. C., 70 miles.

Santa Paula, Ventura County.—P. C. to San Buenaventura, 311 miles; stage, 10 miles; or *a* to Newhall, 452 miles; stage, 40 miles.

Santa Inez, Santa Barbara County.—P. C. to Santa Barbara, 228 miles; stage, 40 miles.

San Margarita, San Luis Obispo County.—*b* to Soledad, 143 miles; stage 104 miles; or P. C.

Santa Maria, Santa Barbara County.—P. C. to Port Harford, 201 miles; P. C. Ry., 42 miles.

Santa Maria, San Diego County.—*a* to Colton, 540 miles; C. S. to San Diego, 121 miles; stage, 38 miles; or P. C.

Santa Monica, Los Angeles County.—*a* 500 miles; or P. C., 361 miles.

Santa Rita, Monterey County.—*b* to Salinas, 118 miles; stage, 3 miles.

Santa Rosa, Sonoma County.—S. F. & N. P., 51 miles.

Santa Ynez, Santa Barbara County.—P. C. to Port Harford, 201 miles; P. C. Ry., 64 miles; stage, 15 miles.

Saratoga, Santa Clara County.—S. P. C. to Los Gatos, 55 miles; stage, 4 miles; or *b* to Santa Clara, 47 miles; stage, 8 miles.

Sargents, Santa Clara County.—*b* 86 miles.
Saucelito, Marin County.—N. P. C., 6 miles.
Savanna, Los Angeles County.—*a* 494 miles.
Sawyers Bar, Siskiyou County.—*a* to Delta, 272 miles; stage, 110 miles.
Scott Bar, Siskiyou County.—*a* to Delta, 272 miles; stage to Fort Jones, 65 miles; saddle train, 20 miles.
Searsville, San Mateo County.—*b* to Redwood, 29 miles; stage, 9 miles.
Sebastopol, Sonoma County.—S. F. & N. P. to Santa Rosa, 51 miles; stage, 6 miles.
Selma, Fresno County.—*a* 222 miles.
Sepulveda, Los Angeles County.—*a* 474 miles.
Selwyns, San Diego County.—*a* to Colton, 540 miles; C. S., 108 miles.
Sesma, Tehama County.—*a* 212 miles.
Seven Palms, San Diego County.—*a* 591 miles.
Seventy Mile Siding, San Diego County.—*a* to Colton, 540 miles; C. S., 56 miles.
Shady Run, Placer County.—*a* 163 miles.
Shasta, Shasta County.—*a* to Redding, 234 miles; stage, 6 miles.
Shaws Flat, Tuolumne County.—*a* to Milton, 122 miles; stage, 30 miles.
Shaws, Butte County.—*a* 191 miles.
Sheep Ranch, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage, 27 miles.
Shelter Cove, Mendocino County.—P. C., 167 miles.
Sheridan, Placer County.—*a* 126 miles.
Sherwood Valley, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 66 miles.
Shingle Springs, El Dorado County.—*a* to Sacramento, 90 miles; S. & P., 48 miles.
Shorb, Los Angeles County.—*a* 489 miles.
Siberia, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 141 miles.
Sierra City, Sierra County.—*a* to Marysville, 142 miles; stage, 79 miles; or *a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 57 miles.
Sierra Madre Villa, 1 mile from Lamanda Park and 13 miles from Los Angeles via Los Angeles and San Gabriel Valley R. R.
Sierraville, Sierra County.—*a* to Truckee, 209 miles; stage, 30 miles.
Signal Port, Mendocino County.—N. P. C. to Duncan Mills, 79 miles; stage, 8 miles.
Silver Mountain, Alpine County.—*a* to Reno, 244 miles; V. & T. to Carson, 31 miles; stage, 54 miles.
Simi, Ventura County.—*a* to Newhall, 452 miles; stage, 35 miles; or P. C. to San Buenaventura, 311 miles; stage, 15 miles.
Silsby, Butte County.—*a* 169 miles.
Skaggs Springs, Sonoma County.—S. F. & N. P. to Clairville, 75 miles; stage, 8 miles.
Slate Creek, Shasta County.—*a* to Delta, 272 miles; stage, 44 miles.
Smartsville, Yuba County.—*a* to Marysville, 142 miles; stage, 18 miles.
Smiths River, Del Norte County.—Stmr, 298 miles.
Snelling, Merced County.—*a* to Merced, 152 miles; stage, 16 miles.
Sobrante, Contra Costa County.—*a* 21 miles.
Soda Bay, Lake County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Lakeport, 40 miles; stmr., 10 miles; or *a* to Calistoga, 73 miles; stage to Lakeport, 46 miles; stmr., 10 miles.
Soda Springs, Nevada County.—*a* 192 miles.

Soda Springs, Siskiyou County.—*a* to Delta, 272 miles; stage, 41 miles.

Soda Springs, Napa County.—*a* to Napa, 46 miles; stage, 7 miles.

Soledad, Monterey County.—*b* 143 miles.

Somersville, Contra Costa County.—*a* to Los Medanos, 51 miles; Pittsburg R. R., 6 miles.

Sonoma, Sonoma County.—*a* to Napa, 46 miles; stage, 15 miles; or S. V., 38 miles.

Sonoma Mills, Sonoma County.—N. P. C., 72½ miles.

Sonora, Tuolumne County.—*a* to Milton, 122 miles; stage, 35 miles.

Soquel, Santa Cruz County.—*b* 116 miles; or P. C.

Soto, Tehama County.—*a* 200 miles.

South Eel River, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 65 miles.

Southerns, Shasta County.—*a* to Delta, 272 miles; stage, 54 miles.

Spadra, Los Angeles County.—*a* 511 miles.

Spanish Dry Diggings, El Dorado County.—*a* to Auburn, 126 miles; stage, 14 miles.

Spanish Ranch, Plumas County.—*a* to Marysville, 142 miles; N. C. to Oroville, 28 miles; stage, 57 miles.

Spanishtown (Half Moon Bay), San Mateo County.—*b* to San Mateo, 21 miles; stage, 13 miles.

Spring Valley, Colusa County.—*a* to Williams, 125 miles; stage, 12 miles.

Springfield, Tuolumne County.—*a* to Milton, 122 miles; stage, 30 miles.

Springville, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage to Hydesville, 182 miles; E. R. & E. R. R. to Springville.

Spruce Grove, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 116 miles.

Stanfords, Nevada County.—*a* 204 miles.

Starveout, Siskiyou County.—*a* to Delta, 272 miles; stage, 165 miles.

Stege, Alameda County.—*a* 14 miles.

Steeles, San Luis Obisbo County.—P. C. to Port Harford, 201 miles; P. C. Ry., 16 miles.

Stewarts, San Diego County.—*a* to Colton, 540 miles; C. S., 85 miles.

St. Helena, Napa County.—*a* 64 miles.

St. John, Colusa County.—*a* to Williams, 125 miles; stage, 50 miles.

St. Louis, Sierra County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 51 miles.

Stockton, San Joaquin County.—*a* 92 miles.

Stock Yards, Alameda County.—*a* 9 miles.

Strawberry Valley, Siskiyou County.—*a* to Delta, 272 miles; stage, 40 miles.

Strongs, Nevada County.—*a* 203 miles.

Strongs, Humboldt County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 172 miles.

Sugar Pine, Tuolumne County.—*a* to Milton, 122 miles; stage, 49 miles.

Suisun, Solano County.—*a* 49 miles.

Sulphur Creek, Colusa County.—*a* to Williams, 125 miles; stage, 40 miles.

Summer Home Farm, Santa Cruz County.—S. P. C. to Glenwood, 66 miles; stage, 3 miles.

Summit, Nevada County.—*a* 195 miles.

Summit, Marin County.—N. P. O., 11 miles.

Sumner, Kern County.—*a* 314 miles.

Sunol, Alameda County.—*a* 37 miles.

Susanville, Lassen County.—*a* to Reno, 244 miles; N. & C. to Moran, 39 miles; stage, 57 miles: or *a* to Chico, 186 miles; stage, 85 miles.

Sutter Creek, Amador County.—*a* to Ione, 140 miles; stage, 12 miles.

Swansea, Inyo County.—*a* to Reno, 244 miles; V. & T. to Mound House, 41 miles; C. & C., 290 miles.

Sweetland, Nevada County.—*a* to Marysville, 142 miles; stage, 37 miles.

Sycamore, Fresno County.—*a* 197 miles.

Table Bluff, Humboldt County.—P. C. to Eureka, 219 miles; stage, 15 miles.

Tagus, Tulare County.—*a* 247 miles.

Tahoe City (Lake Tahoe), Placer County.—*a* to Truckee, 210 miles; stage, 14 miles.

Tamalpais, Marin County.—N. P. C., 14 miles.

Tamarack, Placer County.—*a* 185 miles.

Tamarack Flat, Mariposa County.—*a* to Milton, 122 miles; stage, 70 miles.

Taylorville, Plumas County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 105 miles; or *a* to Chico, 186 miles; stage, 85 miles; or *a* to Reno, 244 miles; N. & C. to Moran, 39 miles; stage, 55 miles.

Taylorville, Marin County.—N. P. C., 30 miles.

Teal, Solano County.—*a* 44 miles.

Tehachapi, Kern County.—*a* 362 miles.

Tehama. Tehama County.—*a* 187 miles,

Telegraph City, Calaveras County.—*a* to Milton, 122 miles; stage, 5 miles.

Temecula, San Diego County.—*a* to Colton, 540 miles; C. S., 49 miles.

Temescal, Alameda County.—*a* to Oakland, 8 miles; street railroad, 2 miles.

Tennants, Santa Clara County.—*b* 71 miles.

The Needles, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 240 miles.

Thompsons Flat, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 2½ miles.

Timber Cove, Sonoma County.—N. P. C. to Duncan Mills, 79 miles; stage, 19 miles.

Timbuctoo, Yuba County.—*a* to Marysville, 142 miles; stage, 18 miles.

Tipton, Tulare County.—*a* 262 miles.

Tocaloma, Marin County.—N. P. C., 32 miles.

Todds Valley, Placer County.—*a* to Auburn, 126 miles; stage, 20 miles.

Tomales, Marin County.—N. P. C., 55 miles.

Tortuga, San Diego County.—*a* 677 miles.

Tormey, Contra Costa County.—*a* 27 miles.

Tower House, Shasta County.—*a* to Delta, 272 miles; stage, 18 miles.

Towles, Placer County—*a* 159 miles.

Town Talk, Nevada County.—*a* to Colfax, 144 miles; N. C., 20 miles.

Tracy, San Joaquin County.—*a* 72 miles.

Tres Pinos, San Benito County—*b* 100 miles.

Tremont, Solano County.—*a* 73 miles.

Trigo, San Joaquin County.—*a* 115 miles.

Trinidad, Humboldt County.—P. C., 233 miles.

Trinity Centre, Trinity County.—*a* to Delta, 272 miles; stage, 51 miles.

Trubody, Napa County.—*a* 54 miles.

Truckee, Nevada County.—*a* 209 miles.

Truitts, Sonoma County.—S. F. & N. P., 86 miles.

Tulare, Tulare County.—*a* 251 miles.
Tunnel, Los Angeles County.—*a* 456 miles.
Turlock, Stanislaus County.—*a* 127 miles.
Tuscan Springs, Tehama County.—*a* to Red Bluff, 199 miles; stage, 7 miles.
Tustin City, Los Angeles County.—*a* to Anaheim, 516 miles; stage, 7 miles.
Tuttletown, Tuolumne County.—*a* to Milton, 122 miles; stage, 26 miles.
Two Rocks, Sonoma County.—S. F. & N. P. to Petaluma, 36 miles; stage, 8 miles.
Tyler, Tehama County.—*a* 188 miles.
Tylers, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 18 miles.
Tyrone Mills, Sonoma County.—N. P. C., 74 miles.

Ukiah, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 30 miles.
Uniontown, El Dorado County.—*a* to Auburn, 126 miles; stage, 9 miles.
Upper Lake, Lake County.—*a* to Calistoga, 73 miles; stage to Lower Lake, 35 miles; stmr., 20 miles; or S. F. & N. P. to Cloverdale, 84 miles; stage, 50 miles.

Vacaville, Solano County.—*a* to Elmira, 60 miles; V. V. & C. L., 4 miles.
Vallecito, Calaveras County.—*a* to Milton, 122 miles; stage, 29 miles.
Vallejo, Solano County.—*a*, 32 miles; or stmr., 27 miles.
Vallejo Junction, Solano County.—*a* 29 miles.
Valley Ford, Sonoma County.—N. P. C., 61 miles.
Valley Spring, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N., 28 miles.
Valona, Contra Costa County.—*a* 30 miles.
Vega, Monterey County.—*b* 96 miles.
Venada, Colusa County.—*a* to Williams, 125 miles; stage, 13 miles.
Ventura, Ventura County.—P. C., 311 miles.
Vina, Tehama County.—*a* 205 miles.
Vincent, Los Angeles County.—*a* 421 miles.
Vineland, Napa County.—*a* 63 miles.
Virginia, Placer County.—*a* to Lincoln, 119 miles; stage, 6 miles.
Visalia, Tulare County.—*a* to Goshen, 241 miles; Visalia R. R., 9 miles.
Volcano, Amador County.—*a* to Ione, 140 miles; stage, 25 miles.
Volcano Springs, San Diego County.—*a* 661 miles.

Wade, Kern County.—*a* 321 miles.
Walkers Landing, Sacramento County.—Stmr., 92 miles.
Wallace, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N., 18 miles.
Walnut Creek, Contra Costa County.—*a* or S. P. C. to Oakland, 8 miles; stage, 17 miles.
Walnut Grove, Napa County.—*a* 70 miles.
Walters, San Diego County.—*a* 625 miles.
Walthall, San Joaquin County.—*a* 101 miles.
Warm Springs, Alameda County.—*a* 37 miles.
Warners Ranch, San Diego County.—*a* to Colton, 540 miles; and C. S. to San Diego, 121 miles; stage, 60 miles; or P. C.
Washington, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 21 miles.

Washington, Yolo County.—*a* 90 miles.
Washington Corners, Alameda County.—*a* 34 miles.
Waterloo, San Joaquin County.—*a* to Stockton, 92 miles; stage, 10 miles.
Waterman, San Bernardino County.—*a* to Mojave, 382 miles; A. & P., 70 miles.
Watsonville, Santa Cruz County.—*b* 101 miles.
Waverly, San Joaquin County.—*a* 114 miles.
Webster, Yolo County.—*a* 81 miles.
Weaverville, Trinity County.—*a* to Delta, 272 miles; stage, 46 miles.
Webbs Landing, Contra Costa County.—Stmr., 53 miles.
Webber Lake, Sierra County.—*a* to Truckee, 209 miles; stage, 24 miles.
Westport, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 95 miles.; or N. P. C. to Duncan Mills, 79 miles; stage, 125 miles.
West Berkeley, Alameda County.—*a* 10 miles.
West Oakland, Alameda County.—*a* 6 miles.
West Point, Calaveras County.—*a* to Lodi, 104 miles; S. J. & S. N. to Valley Spring, 28 miles; stage, 29 miles.
Wheatland, Yuba County.—*a* 130 miles.
Westminster, Los Angeles County.—*a* to Anaheim, 509 miles; stage, 4 miles; or P. C.
Whisky Hill, Santa Cruz County.—*b* to Watsonville, 101 miles; stage, 2 miles.
Whitelys Ford, Modoc County.—*a* to Delta, 272 miles; stage, 135 miles.
Whitehall, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 15 miles.
Whitneys, Sutter County.—*a* 114 miles.
White Rock, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 29 miles.
White Sulphur Springs, Napa County.—*a* to St. Helena, 64 miles; stage, 3 miles.
Whitewater, San Diego County.—*a* 583 miles.
Whitesboro, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; N. P. C. to Duncan Mills, 79 miles; stage, 87 miles; or P. C.
Wilburs Hot Springs, Colusa County.—See Sulphur Creek.
Williams, Colusa County.—*a* 125 miles.
Williamsons, Sacramento County.—*a* to Sacramento, 90 miles; S. & P., 14 miles.
Willits, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 54 miles.
Willmore, Los Angeles County.—*a* 500 miles.
Willows, Colusa County.—*a* 151 miles.
Wilmington, Los Angeles County.—P. C., 392 miles; or *a* 504 miles.
Windsor, Sonoma County.—S. F. & N. P., 60 miles.
Winters, Yolo County.—*a* to Elmira, 60 miles; V. V. & C. L., 17 miles.
Woodbridge, San Joaquin County.—*a* to Lodi, 104 miles; S. J. & S. N., 3 miles.
Woodfords, Alpine County.—*a* to Reno, 244 miles; V. & T. to Carson, 31 miles; stage, 30 miles.
Woodland, Yolo County.—*a* 86 miles.
Woodside, San Mateo County.—*b* to Redwood, 29 miles; stage, 6 miles.
Woodville, Tulare County.—*a* to Goshen, 241 miles; V. to Visalia, 7 miles.
Woolseys Flat, Nevada County.—*a* to Colfax, 144 miles; N. C. to Nevada, 22 miles; stage, 16 miles.
Wrights, Santa Clara County.—S. P. C., 62 miles.

Wrights Hotel, Santa Clara County.—S. P. C., to Wrights, 63 miles; stage, 2 miles.

Wyandotte, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 6 miles.

Yankee Hill, Butte County.—*a* to Marysville, 142 miles; C. N. to Oroville, 28 miles; stage, 18 miles.

Yankee Jims, Placer County.—*a* to Auburn, 126 miles; stage, 18 miles.

Yorkville, Mendocino County.—S. F. & N. P. to Cloverdale, 84 miles; stage, 20 miles.

Yosemite Valley, Mariposa County.—*a* to Raymond (end of new Yosemite extension), 200 miles; stage via Mariposa Big Trees, 60 miles; or *a* to Milton via Stockton, 143 miles; stage, 85 miles.

Yolo, Yolo County.—*a* 91 miles.

You Bet, Nevada County.—*a* to Dutch Flat, 157 miles; stage, 7 miles.

Yountville, Napa County.—*a* 55 miles.

Yreka, Siskiyou County.—*a* to Delta, 272 miles; stage, 115 miles.

Ysidora, San Diego County.—*a* to Colton, 540 miles; C. S., 75 miles.

Yuba City, Sutter County.—*a* 141 miles.

Yucca, Kern County.—*a* to Mojave, 382 miles; A. & P., 20 miles.

INDEX.

A

B

C

D

E

F

G

H

I

K

L

M

S

T

CALIFORNIA STATE MINING BUREAU.

WILLIAM IRELAN, JR., STATE MINERALOGIST.

SEVENTH ANNUAL REPORT

OF THE

STATE MINERALOGIST.

FOR THE YEAR ENDING OCTOBER 1, 1887.

SACRAMENTO:
STATE OFFICE : : : J. D. YOUNG, SUPT. STATE PRINTING.
1888.

CALIFORNIA STATE MINING BUREAU.

WILLIAM IRELAN, JR., STATE MINERALOGIST.

SEVENTH ANNUAL REPORT

OF THE

STATE MINERALOGIST.

FOR THE YEAR ENDING OCTOBER 1, 1887.

SACRAMENTO:
STATE OFFICE : : : : J. D. YOUNG, SUPT. STATE PRINTING.
1888.

By mail

TABLE OF CONTENTS.

To Honorable R. W. WATERMAN, *Governor:*

SIR: The Trustees of the State Mining Bureau herewith submit their report, in pursuance of the Act of the Legislature entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau, approved April 16, 1880,' approved March 21, 1885."

Respectfully,

J. Z. DAVIS,
G. W. GRAYSON,
W. S. KEYES,
S. HEYDENFELDT, JR.

OCTOBER 1, 1887.

NOTE.—Hon. GEORGE HEARST, Trustee, was absent when the report was made.

REPORT OF TRUSTEES OF STATE MINING BUREAU.

Since the publication of the sixth annual report of the State Mineralogist and of the Trustees, the work of the Bureau has made most gratifying progress, and has, we think, met the approval of all classes of the community. The scope of its investigation has been enlarged, and a good beginning has been made in carrying out the plans and purposes of the Act of April 16, 1880, providing for the establishment and maintenance of a State Mining Bureau. A chemical laboratory (heretofore so greatly needed) has been constructed and sufficiently equipped to enable the chemists of the Bureau to do a great deal of necessary work.

GEOLOGICAL FIELD WORK.

In pursuance of the Act of the State Legislature, approved March 9, 1887, requiring that one half the amount appropriated for the support of the Bureau for the thirty-ninth and fortieth fiscal years be used for geological work in the field, the Trustees have secured the services of experts, eminent in their several specialties, who have most generously devoted their time and talent to the public service, for what the Trustees are constrained to admit is an inadequate renumeration; nevertheless their zeal has not flagged and their work speaks for itself.

These attachés of the Bureau, appointed after consultation with, and the approval of, the State Mineralogist, are in the order of their appointment as follows: Watson A. Goodyear, Melville Attwood, Adolph H. Weber, and Dr. W. D. Johnston.

The Trustees are pleased to acknowledge the cordial relations established and at present existing between the Bureau and all other State institutions, and particularly with the University of California. Professor Jackson has, in conjunction with the State Mineralogist, undertaken the examination and testing of the various building stones occurring in our State. The Bureau has caused to be forwarded to quarrymen, architects, and builders, a circular asking for samples for testing. The response has not, as yet, been commensurate with the importance of the subject, but it is hoped and expected that many more specimens will, in the near future, be sent in for examination, to the great practical advantage of owners, workers, and users of such material. The circular is inserted in the report of the State Mineralogist.

VISITORS.

Over thirteen thousand persons have visited and inspected the collection in the Bureau, whose names appear on the register, during the past year; in addition a large number have failed to register.

MUSEUM.

The exhibits displayed in the Museum have shown a most gratifying increase, not only in objects directly cognate to the work of the Bureau, but also in the interesting subjects of ethnology, conchology, ornithology, etc.

The Museum has been enriched by the gift of many interesting exhibits, which add greatly to the value of the display and prove the liberality and devotion to practical science of many of our fellow citizens. The only regret of the Trustees is that the space is already too limited, so that much attractive material is unavoidably stored in boxes.

LIST OF DONORS TO MUSEUM FROM OCTOBER, 1886, TO OCTOBER, 1887.

Acker, E. O. C.
Aldrich, H. A.
Attwood, Melville.

Bacon, Frank M.
Baker, J. C.
Barnes, Henry.
Barney, Jas. M.
Batchelder, C. S.
Bell, Edmund.
Bell, J. W.
Bennett, L. J.
Blacklock Quarry Company.
Blake, Prof. William P.
Blanding, Louis.
Bowen, H. A.
Boynton, B. R.
Bradford, Miss M.
Brady, O. E.
Braverman, M.
Brewer, Dr. B. B.
Brittan, W. G.
Bromley, Miss Carrie.
Brown, George L.
Brown, James B.
Brown, William.
Bryant, John.
Bugbee, S. W.
Burbridge, S. L.
Burnell, W.
Bush, Mrs. A. E.

Campbell, H. H.
Chambers, R. C.
Chapman, Major John.
Clark, T. P.
Cohen, Mrs. M.
Cohen, Morris.
Cohen, Hon. Richard.
Collins, D. W.
Collins, John.
Corbett, W. S.
Cornish, Mark.
Corrington, W. R.
Crawley, C. C.
Cresswell, John.
Cronise, W. H. V.

Daggett, Hon. John.
Dana, A. W.
Davidson, T.
Davis, George.
Davis, J. A.
Davis, J. Z.
Deney, L. B.
Detert, W. F.
Dickey & Co.
Dickinson, Thos.
Dolman, G. B.
Donnelly, Dr. E.
Doutrick, Frank.
Dunn, R. G.
Dunn, R. L.
Durden, H. S.

Edwards, H. J.
El Dorado Slate Company.
Ellenwood, Wm.
Epperson, J. M.
Evans, L.

Farwell, Captain J. D.
Fehser, F. W.
Flanagan, T. L.
Fleming, E. C.
Flint, Thomas, Jr.
Fielding, Frank E.
Fitzgerald, Chas.
Foorman, S.
Fowler, W.

Gallagher, Edward A. T.
Glass, Louis.
Gibb, R. B.
Goodyear, W. A.
Graham, John.
Grayson, G. W.
Greene & Spencer.

Hanson, J. W.
Hanks, H. G.
Harlan, C. C.
Harper, John.
Harmony Borax Company.
Hatsell, John.
Hausman, F. H.
Hay, T. J.
Healey, P. J.
Hearst, Hon. George.
Heath, Wm. McK.
Hellmann, Fred.
Henderson, W. A.
Hentz, A. H.
Heslewood, J. A.
Heydenfeldt, Judge S.
Heydenfeldt, S., Jr.
Hgule, Mr.
Hill, Benj.
Hindley, Mr.
Hitchcock, C. A.
Holcombe, S. E.
Holmes, A. J.
Holt, J. H.
Humboldt County Fair Association.
Hutchins, E. P.

Idaho Mining Company G. V.
Irelan, William, Jr.

Jack, R. E.
Jackson, J. P.
Johnston, Dr., William D.
Jordan, J. L.
Judson, A.
Jutton, D.

Kaneko, S.
Kates, J. P.
Kaufman, Charles.
Kelley, Jay G.
Kelley, J. M.
Kellogg, L. C.
Kelly, John W.
Keil, Frederick C.
Kennedy, John F.
Keyes, W. S.
King, Richard H.
Knox, W. C.

Larkin, Frank.
Leadbetter, C. H., Jr.
Leviston, William.
Liddell, W. H.
Litten, W. P.
Livingston, C. H.
Lord, A. R.
Lorquin, E. F.
Lovelock, Mrs. George.
Lyle, W. S.

McCuen, John.
Madden, William J.
Markson, Phil. A.
Martin Brothers.
Martin, G. W.
Maxwell, John W. C.
Maxwell, Dr. R. T.
Maynard, Miss M.
Melville, H. F.
Mèyer, A.
Millard, W. L.
Minckler, W. D.
Mitchell, H. K.
Monteverde, F. E.
Moore, Lewis A.
Morgan, D. W. C.
Mount Shasta Chrome Mining Company.

Nevada County Fair Association.

Patten, Daniel.
Patton, W. H.
Paul, A. B.
Pierce, Owen
Pierce, Webb N.
Pittard, H. L.
Porter, Dr. Thomas.
Porterie, Alex.
Powell, Dr.
Powell, J. W.
Prefumo, P. B.
Presho, James.
Provincial Secretary's Department, British Columbia.

Quimet, L. H.

Rangely, Robert.
Reeg & Landecker.
Reeves, C. P.

Reynegom, F. W., Van.
Richards, John.
Riddle, Hon. John A.
Robinson, William.
Rogers, E. J.
Rogers, Mrs. L. S.
Rourke, T. J.
Ryan, J. E.

Sanborn, J. R.
Sargent, Hon. B. V.
Sato, N.
Schneider, C. G.
Schubert & Kruft.
Scupham, J. R.
Shasta County Fair Association.
Sinton, R. H.
Skinner, James T.
Smith, E. Martin.
Smith, H
Smith, W. H.
Sonnenfeld, Samuel.
Southern Ledge Stone Company.
Spates, K.
Spring, Menzo.
Spurrier, G.
Staddon, Samuel.
Stansfield H.
Stockton, William.
Stone, Mrs. A. J.
Stough, Mrs. J. P.
Stow, H. R.
Sublette, William.
Sutro, A.
Switzer, John.

Taylor, B. R.
Tehachapi Stone and Marble Company.
Terry, L. A.
Thomas, F. F.
Thompson, M.
Thurber, J. L.
Titus, J. S., Jr.
Towle Brothers.
Treadwell, J. B.
Tyson, Mrs. J.

Valencia, J. C.
Verger, J. A.
Victor Marble Company.
Vulcan Powder Company.
Ward, William.
Warren, Mrs. S. A.
Watson, G.
Watts, W. L.
Weber, A. H.
Weinberg, E. A.
Weiss, J. S.
Wheeler, M. A.
White, Miss Bertha A.
White, Charles W.
White, D. Morgan.
Winants, N.
Williams, H.
Williams, J. G.
Williams, Mr.
Wilson, John.
Wilton, W. H.
Wolleb, E.
Wood, R. E.
Woodhull, S. D.
Woodward, W. A.
Wores, Charles R.
Wren, Hon. Thomas.

Yreka Journal, Proprietors of.
Young, N. G.

FACILITIES FOR RECEIVING SPECIMENS.

Wells, Fargo & Co. continue to favor the State Mining Bureau by delivering free, packages weighing less than twenty pounds, from all parts of the Pacific Coast.

We are also pleased to acknowledge the kindness of Goodall, Perkins & Co. for gratuitously transporting packages to the State Mining Bureau, on their line of Pacific Coast steamers.

LIBRARY.

The Library, in view of the short time taken for its collection, is particularly well supplied with all the more recent standard books and treatises on mining, mineralogy, metallurgy, geology, etc. We are indebted to Senators Leland Stanford, J. P. Jones, Geo. Hearst, and Wm. M. Stewart for many valuable books of reference, and also to our Representatives in Congress, who have taken great interest in the welfare of the Bureau.

The Library possesses, amongst other rare and valuable publications, a complete set of the United States Geological Survey Reports, a complete set of the proceedings of the "American Institute of Mining Engineers" (due to the courtesy of the Institute, through its Secretary, Dr. R. W. Raymond); many of the Geological Survey publications of the various States of the Union, and a very complete set of monographs and industrial pamphlets, which are conveniently arranged and indexed for public consultation. Since the issue of the last report there has been an increase of over seven hundred books, besides many valuable pamphlets.

NEWSPAPERS.

The following newspapers continue to be sent to the State Mining Bureau free:

Arizona Gazette, Phœnix, Arizona.
Humboldt Standard, Eureka, Humboldt County, California.
The Mountain Messenger, Downieville, Sierra County, California.

The Free Press, San Buenaventura, Ventura County, California.
Grass Valley Daily Union, Grass Valley, California.
California Demokrat, San Francisco, California.
Inyo Independent, Independence, Inyo County, California.
Mining and Industrial Advocate, San Francisco, California.
Mining Review, Chicago, Illinois.
Financial Mining Record, New York.
Wood and Iron, Minneapolis, Minnesota.
The Weekly Star, San Francisco, California.
West American Scientist, San Diego, California.

ACCOUNTS FROM OCTOBER 1, 1886, TO OCTOBER 1, 1887.

Receipts.

Balance, October 1, 1886	$9,207 13
Paid into Mining Bureau Fund	6,893 90
Appropriation, July 1, 1887	30,000 00
Total	$46,101 03

Disbursements.

Rent	$2,775 00
Salary of State Mineralogist	3,000 00
Salaries	3,950 50
Salaries (geological field work)	1,780 00
Museum	763 20
Library	2,076 41
Minerals	961 80
Postage	659 25
Traveling expenses	552 75
Traveling expenses (geological field work)	989 60
Laboratory	2,327 85
Clerical assistance	262 60
Freight and express charges	218 85
Sundries	612 99
Sundries (geological field work)	52 65
Wells, Fargo & Co.	1,984 37
Total	$22,967 82
Balance of appropriation and in Mining Bureau Fund	23,133 21
	$46,101 03

To his Excellency, R. W. WATERMAN, *Governor of the State of California:*

SIR: In accordance with the Act of the Legislature entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880, I herewith transmit my report.

Very respectfully,

WM. IRELAN, JR.,
State Mineralogist.

SAN FRANCISCO, October 1, 1887.

REPORT OF THE STATE MINERALOGIST.

The greater part of the material embodied in this report was obtained by those connected with the State Mining Bureau through personal observations which necessitated actual inspection of the fields of operation.

All attachés of the Bureau have been received with uniform kindness and courtesies in all parts where their respective investigations required their presence.

The Trustees have been unremitting in their attention to the affairs of the institution, and it is largely due to their personal efforts that the Bureau, having specially in view the development of the economic minerals of the State, ranks with any similar establishment in the world. Great obligations are due to those who have so kindly assisted us in our endeavors to give to the public the capabilities of our State.

To Mr. J. Z. Davis, Chairman of the Board of Trustees of the State Mining Bureau, we are especially indebted for his generous donations, which have so largely added to the usefulness of the institution and to the attractions of the Museum.

The report is confined to the subjects of Petroleum, Asphalts, Natural Gas, Coals, and Building Stones, for the reason that very little information has been published as to their existence and extent in the State, notwithstanding the fact that their great importance is universally recognized. Furthermore, the fund appropriated for geological field work by the last Legislature only became available in July, and in consequence the time to make investigations of the other various economic minerals occurring so abundantly throughout the State was limited.

To the lateness in entering the field is likewise due the want of time necessary to make as comprehensive or complete analyses of the material gathered as wished for.

ORIGIN OF PETROLEUM.

It is a theory generally accepted that organic remains were the original matter from which petroleum originated, but just how or through what agency the oil was freed or produced is a problem whose solution seems to be very remote. The once popular theory that petroleum was the natural product of coal is altogether of the past, as the many deep wells have proven that the oil-bearing strata lie far below the coal beds.

It is manifest that limestone was the primitive depository of the original substance, and that the gas which was set free at the time of the chemical decomposition of the organic matter, or the water contained in the fissures of the rock, or both, were the agents that furnished the power to drive the oil into the less compact sandstones and shales. It might here be mentioned that Mr. Carll, the eminent geologist, says, an oil sand is capable of absorbing one tenth of its bulk in oil, and under pressure even as much as one eighth.

The natural petroleum springs of California in many cases show by the ebb and flow of the liquid, and the many bubbles coming to and bursting on the surface, that in most instances gas is the special power; therefore it seems safe to predict that where natural illuminating gas is found in well-boring petroleum is close by.

Hon. J. P. Lesley, the State Geologist of Pennsylvania, says: "The origin of petroleum is still an unsolved problem. That it is in some way connected with the vastly abundant accumulation of paleozoic sea-weed, the marks of which are so infinitely numerous in the rocks, and with the infinitude of coralloid sea animals, the skeletons of which make up a large part of the limestone formations which lie several thousand feet beneath the Venango oil sand group, scarcely admits of dispute; but the exact process of its manufacture, of its transfer, and its storage in the gravel beds, is utterly unknown. That it ascended into them rather than descended seems indicated by the fact that the lowest sands hold oil when those above do not, and that the upper sands hold oil when they extend beyond or overhang the lower."

PETROLEUM FIELDS OF CALIFORNIA.

The petroleum fields of California where oil is found in merchantable quantities are almost exclusively within the boundaries of the southern counties, yet the oil has been found in other parts of the State, but not in sufficient quantity to warrant much expenditure. It is to be regretted that the shortness of time at our disposal is not sufficient to do justice to the importance of the subject. W. A. Goodyear and A. H. Weber, field assistants of the State Mineralogist, were delegated to work up the petroleums, coals, and natural gas branches of the State's industry, and the reports of their investigations and deductions are embodied herewith. Enough facts have been gathered to give a fair idea of what is being done and a pretty correct statement of the output of the wells. Pennsylvania is really the cradle of the petroleum industry, and our oil men must needs draw largely from her experience and study carefully the opinions of her very able geologists who have devoted the better part of a lifetime in endeavoring to solve its many problems. With a better knowledge of the geology of the petroleum fields of our State, we may in the future be able to prospect for oil with an equal success of reward as the miner for gold upon the auriferous belt; not that the miner is always successful or does not make many failures, but his knowledge, obtained by experience and observation, has taught him that gold is more likely to be found in certain formations. The "practical miner," as well as the "practical oil man," is disposed to condemn any one who may draw inferences not in harmony with their opinions. The ability to be able to locate with a possible chance of success is not of itself practical, but is a knowledge acquired by theory and study applied to practical uses, and the following will more fully explain the advantages of such acquirements.

Extracts of the letter of transmission of the Hon. J. P. Lesley, Geologist of the State of Pennsylvania, to his Excellency Governor Henry M. Hoyt, Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania, dated at Philadelphia, October 25, 1880. In writing of Mr. John F. Carll, the geologist in charge of the oil regions of that State, Mr. Lesley says:

"The main feature of the report is the settlement of the true character of the Venango oil sand group as a distinct and separate deposit, with characteristic marks distinguishing it from the paleozoic formations of a preceding and a succeeding age; the differentiation of the group into three principal and other subordinate layers of gravelly sand, holding more or less oil and gas; the local variability of these sands, their singular persistency beneath long and narrow belts of country, their change into barren

shales elsewhere, and their independence of other oil-bearing sands and shales of an earlier and of a later date.

"Seeking for oil in unexplored ground, is like seeking for tobacco in a smuggler's trunk. The traveler and his luggage look suspicious; that is the full extent of the customs officer's knowledge. The tobacco must be found, if at all, with the probe. The officer's instinct may be deceived; the trunk may have no false bottom; or the false bottom may hold no tobacco.

"Just so, the geologist who knows the district knows more than the oil man, but he does not know whether sand exists at a given spot beneath the surface; nor whether, if there be a sand, it holds oil or not; nor whether, if the oil be there, it will flow towards a drill hole. But this ignorance of facts, all of them out of sight and out of reach before experiment, he shares with everybody else. No one, absolutely, no one, can know such facts before a well is bored.

"But what the geologist does know is the depth beneath the surface at a given spot at which a given oil-sand in the series ought to lie, and consequently the depth of a required trial hole. This fact men who are not geologists may also be acquainted with in the immediate neighborhood of productive wells, or in a local district where they are familiar. But let them go to other localities, more or less distant, and their knowledge becomes ignorance, because it is restricted by special experience. Whereas the geologist carries his knowledge of one locality with him to another, because *his* knowledge is theoretical, that is, reduced to system, and subject to well established laws of earth structure. He knows that no two well records are alike in detail. He is therefore obliged to discover their general or classical resemblance.

"Until practical oil men learn to value the theoretical principles established and illustrated by Mr. Carll, in this report, it cannot be expected to reach its highest pitch of usefulness. That these principles are not visionary will be clear to every thoughtful reader of it. That they are supported by a great multitude of harmonized facts is plainly shown by its maps and sections. That they have virtually governed geologists, even when less well comprehended than Mr. Carll has now made them to be, is a historical fact put on record by printed reports of experts. That they ought to govern explorers of new territory follows as a matter of course; and so far as oil seekers consent to respect the reasonable results of long, close, and experienced investigation, so far will their pecuniary risks be diminished, and the actual cost of discovery be reduced to a minimum.

"A flagrant example of this truth is given by Mr. Carll on page 137, where he describes the disastrous consequences to a great many people of a purely geological, purely theoretical mistake made by the oil men of the "Fourth Sand Belt of Butler County," calling themselves practical men, but working on a theory all the same. Practical men, so called, are just as theoretical, and much more theoretical, than men of science; the distinction being, that the latter base their theories on a wide range of well connected facts, while the former establish theoretical prejudices upon the basis of a comparatively narrow circle of the facts with which they happen to be very familiar.

"The Venango well sinkers had grown accustomed to the three oil sands of Oil Creek, and they constructed and carried with them into the new field a theory of three sands which was merely a local prejudice. The first sand they struck was to them, theoretically, the Venango First Sand, and when they reached a second they theorized upon it as the Venango Second Sand. All they had to do now, according to their former practice and present theory, was to go one stage lower to the Venango Third Sand, and

they would be sure (theoretically) to get great wells. But when they reached their theoretical third sand, it proved to be poor in oil. Their theory, however, arrested them here in spite of their being practical; in fact precisely because they were practical men. They could not be induced to go deeper; they knew what they were about; no geologist could teach them anything; they had worked on Oil Creek; they knew by long experience and at great cost that there existed no oil beneath the third sand; why then should they go deeper?

"Now, the fact is, that as long as they remained practical men on Oil Creek, they were all right; their local theory was a good one. But being merely practical men they were unconscious of the great law that a local theory is not good off its own ground, and must subject itself everywhere else to some larger theory, constructed slowly and painfully, not by practical, but by theoretical men, by men of science, by men who know the *relative value of the theories of practical men.*

"Had the land owners and oil producers of the Fourth Sand Belt respected geological theories enough to take them into consideration, they would have made progress towards profitable truth, by steps taken in the following order: 1. Although their first sand resembled the first sand on Oil Creek, they would have suspected that the same kind of sand might be deposited at different times in different parts of the old water area, and therefore that resemblance did not prove identity. 2. They would have considered the evidence which Mr. Carll published in his first report, proving that the three sands of Oil Creek (sometimes locally subdivided into four or five) form a single group, with hundreds of feet of soft drilling ground over it, and a great depth of soft drilling ground under it; and they would have kept an extra careful record of their drillings, to see if this proved true in their new field. 3. They would have found thus that their three sands in Butler County did *not* form a single group, as on Oil Creek, but that the upper soft drilling ground lay between their Butler first and second sands. 4. This would have led them, *theoretically*, to deepen their wells, in order to make their oil group complete, and they would have found a fourth sand to correspond with the bottom (or third) sand of Oil Creek.

"The consequences of their scorn of theoretical geologists are depicted on page 137 of this volume. Concluding that they were working in a poor field of the third sand (whereas they were really exploiting the second sand), they sold out and moved off. The new comers, influenced insensibly by the light thrown on the region by the geological survey, tried the experiment of sinking deeper, struck the true third sand, and restored the prosperity and reputation of the Butler belt.

"But clinging still to the old error of supposing the uppermost sand to be the Venango First (whereas it was the Third Mountain Sand, or Berea Grit of Ohio; the Pithole Grit of this report), they called the rich, new, lowest sand thus obtained the fourth sand, and insisted on placing it underneath the Venango Third, whereas it is identical with it.

Not only do "practical oil men" theorize in spite of themselves (as their drillings along certain compass lines show in a remarkable manner), but they are as capable of theorizing well, and reaching just conclusions, as thoroughbred geologists are, if they would take the pains: first, to observe the facts; second, to exhibit them properly on paper; and third, to compare together a sufficient number of them, so as to discover their real connection and relationship. No shrewder or more intellectual people exist. No better observers live. If they only believed in scientific methods of research, they would need no enlightenment from geologists. But they

despise a slow, painstaking, accurate, wide extended, systematic investigation. They bring a handful of sand to a geologist and expect him to declare from an examination of it alone, apart from all other circumstances, what rock it comes from, how much oil that rock probably holds, and how fast the oil from it will probably flow, or be pumped. To furnish such an opinion would be mere quackery; and yet on such specimens, and such opinions—opinions called "practical," but which are purely and simply "theoretical," mere prejudices adopted from some former and distant experience—costly and futile attempts are made to open new oil fields in barren measures.

"Oil men ought to make themselves their own geologists. The elements and principles of geology ought to be part of their stock in trade. They have more ample opportunities for acquiring this kind of useful knowledge than any other class of men living. They know and feel the necessity for examining with minute attention the oil sands, and they do this work admirably well when they reach them; but they pay no heed to the geology of the other parts of their bore-hole.

"If they did, the knowledge they would thus get would be of far more importance to them, for it would enable them to compare one well with another and thus cover the true relationships of the oil sands. They form a theory and then examine the facts. A geologist collects and puts together the facts before he allows himself to construct a theory. They theorize that the oil sand they want lies so many hundred feet beneath the surface, and they pay little or no attention to the hundreds of feet of various measures through which they pass in descending to that depth.

"No wonder that they are as liable to blunder in sinking a second hole as in sinking the first. In fact, by this utter disregard of his well records, except just where low sands lie, a man may sink a hundred wells and have no more true, safe, reliable knowledge of the subject than he had at first.

"Nor does time seem to cure the evil, but only to confirm it.

"What was a reproach to the oil-well sinker of ten or fifteen years ago is a reproach to the generality of oil-well sinkers in 1880. Where are the records of the scores of thousands of holes bored? And how absurdly, suicidally indefinite, inexact, fragmentary, and unreliable are the few records which have been made and preserved! What an immense, what an irretrievable loss, not to science merely, but to the intellectual stock in trade of oil men, has happened! It is impossible for a geologist not to feel and speak warmly on such a subject, and it would be shirking a sacred duty if the Geological Survey of Pennsylvania did not do its best to place this flagrant omission of common business precaution, this wholesale waste of valuable business information, this fruitful source of business embarrassment, distraction, and disaster, in its true form and colors, before the eyes of the whole oil-producing community.

"To return to the subject of the importance of geological generalization, as seen in a practical light, I may be permitted to describe in the first person a singular case in point.

"In 1841 I was ordered by the Chief of the First Geological Survey to report on the counties lying along the New York line, and down the eastern bank of the Allegheny River, as far as the Kiskiminetas. Other assistants on that survey had already discovered and reported the geological structure of the Allegheny River and Beaver River water basins, and the rate of descent of the rocks southward and southwestward, in relation to tide level, had been calculated. My business was to follow and locate upon the map the anticlinal and synclinal rolls which locally change and

modify this general dip, and to identify the principal coal beds over a large area.

"After the discovery of petroleum (which, of course, did not in the least set aside or essentially change the structure of western Pennsylvania as established by the first survey), I happened to be employed by the Brady's Bend Company to examine their property, and to give them, among other items, an opinion upon the probable existence and depth of oil beneath it. To do this I merely did what any geologist who had thoroughly studied that country would have done, I calculated the vertical distance from the oil sand on Oil Creek up to coal A; then I calculated the dip of the measures between Oil Creek and Brady's Bend; and then I identified coal A at Brady's Bend. I reported that the Venango oil sand, *if it extended under ground as far as Brady's Bend*, ought to lie at one thousand one hundred feet beneath water level. Any geologist who knew the country could have done this. It required no genius, no uncommon knowledge, nothing but a plain, simple, systematic, or scientific, in other words, true theoretical method of applying known facts for discovering the unknown. Any oil man could have done the same, if he had noticed the rock-layers as he went up and down the river, and put this and that carefully together.

"Yet, when, after a few months, oil was actually struck at Brady's Bend, within a few feet of the depth which I had assigned to it, the astonishment of all classes of oil men was ludicrously extravagant; a score or two of copies were made from the manuscript report, and these copies passed from hand to hand as precious things, and their author was looked upon as a prodigy of mental penetration, and was offered large sums of money to locate wells in different districts; none of which offers, of course, were accepted, because he was as ignorant of the actual existence of an oil-bearing sand in any given locality as everybody else.

"The story has its moral. Let 'practical men' believe in and respect the slowly, carefully reached, conclusions of 'theoretical men' enough to take them into consideration, so far as to comprehend them, and to govern themselves by them in their own collection and collation of facts relating to their own pecuniary interests.

"When a geologist like Mr. Carll has spent years in sifting and comparing the data of a great geological problem, and publishes his mature conclusions in a modest, earnest, plain, unvarnished report like that which is contained in this volume, it is probable, to say the very least, that its value to practical men like oil producers, struggling with immense obstacles to fortune, will be real in proportion to the pains they take to understand it."

Mr. Lesley further states:

"The chemical theory, so called, which looks upon petroleum as condensed from gas, the gas having been previously distilled from the great black slate formations (Marcellus and Genesee) must face the objection that such a process, if chemically possible, which is doubtful, ought to have distributed the oil everywhere, and permanently blackened and turned into bituminous shales the entire thickness of this part of the earth crust for several thousand feet. It fails to explain the petroleum obtainable from the cannel coals and from the roof shales of bituminous coal beds.

"And it fails also to explain the entire absence of petroleum from immense areas of not only shales, but sand and gravel rocks equally underlaid by the Marcellus and Genesee formations.

"The supposed connection of petroleum with anticlinal and synclinal axes, faults, crevices, cleavage planes, etc., is now a deservedly forgotten superstition. Geologists well acquainted with the oil regions never had the

slightest faith in it, and it maintained its standing in the popular fancy only by being fostered by self-assuming experts who were not experienced geologists."

PETROLEUM DEPOSITS IN VENEZUELA.

These deposits have been known from the earliest history of the country, and as early as 1824 samples were sent to the United States and Europe. Although its existence in these parts was known, the knowledge of the extent of the deposit was very meager until, in 1880, E. H. Plumacher, American Consul, embodied a description thereof in the consular report to the United States. The emanation of the oil is accompanied by large quantities of natural gas, which, from time to time, becomes fired, causing irregular flashes of light, which the superstitious, awe-stricken natives attribute to the wrath of Satan.

Mr. Plumacher gives the following description of his observations:

"At a little more than seven kilometers distance from the confluence of the rivers Tara and Sardinarte, there rises a sand bank of about eight or ten meters in height, and it extends for about twenty-five or thirty meters. On its surface is visible a collection of cylindrical holes, apparently artificially made, and of different diameter, through which gush out with violence streams of petroleum mixed with boiling water, causing a noise which might be produced by two or three steamers blowing off steam. This noise may be heard at a considerable distance, and the column of vapor which ascends therefrom would also be perceptible a great way off if the thickness of the forest did not obstruct the view.

"All that land, over a great distance, abounds in petroleum, and it is wonderful what a coolness and luxuriance the forest which shades it preserves. The few who have visited the place in search of balsam copaiva have given it the name of 'El Inferno.' * * * The government has never interested itself with its exploration, neither have any other particular individuals done so, although many have possessed the means and the knowledge adequate to such an undertaking."

PETROLEUM DEPOSITS IN THE ARGENTINE REPUBLIC.

There also comes to us a report of immense oil deposits in the Argentine Republic. One of these deposits is located in the province of Jujuy. It consists of a lake of about eighty-eight acres in extent, and unknown depth, and is covered with a cap of asphalt. The liquid itself is somewhat thick, is of a black color, and has no disagreeable odor.*

Since then I have had assurance from those who have visited that province, that throughout its whole extent there exist these lakes covered with an inflammable liquid like pitch; also bituminous rocks which burn like stove coal, and valleys full of a substance resembling liquid pitch or having the appearance of asphalt; and springs from which flows oil instead of water. Some of these stories seemed so exaggerated as to be almost incredible. I have to inform the Department, however, that Dr. Luis Brackenbusch, Professor of Geology in the University of Cordoba, a scientist of high standing here and in Germany, has just completed a careful survey of the regions referred to, and made a map of the same. The result of his investigations and explorations is somewhat marvelous. After a thorough geological and geographical examination of that province, he makes the announcement that there exist subterranean rivers of liquid

*Consular report, Buenos Ayres, March 4, 1882, E. L. Baker, Consul.

kerosene, whose depth it is not possible yet to determine with precision, and which it will be necessary to learn by means of perforation.*

PETROLEUM, WHERE FOUND.

Petroleum is an article that has a very extensive distribution; in fact, reports of its discovery are received from nearly every country, even England and Scotland being producers to a limited extent; but from no quarter do we have any authentic reports of a largeness of production to equal that of Russia or the United States of America. Reports of the production of the different countries are to be found in the United States consular reports.

PETROLEUM IN RUSSIA.

The accounts of the production of petroleum by the wells at Baku, on the Caspian Sea, though seemingly fabulous, are nevertheless true, as the standing of those who have reported upon the output is beyond a question of doubt.

A very graphic description of the oil fountains of Russia's petroleum belt is given by Mr. Charles Marvin, who visited the fields and spent much time in their investigation, in his published work entitled, "The Region of the Eternal Fire," of which the following is an extract:

"In America there are over twenty-five thousand drilled petroleum wells. Baku possesses four hundred, but a single one of those four hundred wells has thrown up as much oil in a day as nearly the whole of the twenty-five thousand in America put together. This is very wonderful. But a more striking fact is, that the copiousness of the well should have ruined its owners, and broken the heart of the engineer who bored it, after having yielded enough oil in four months to have realized in America at least one million sterling.

"'In Pennsylvania that fountain would have made its owner's fortune; there's £5,000 worth of oil flowing out of the well every day. Here it has made the owner a bankrupt.' These words were addressed to me by an American petroleum engineer, as I stood alongside a well that had burst the previous morning, and out of which the oil was flying twice the height of the Great Geyser in Iceland, with a roar that could be heard several miles around. The fountain was a splendid spectacle—it was the largest ever known at Baku. When the first outburst took place, the oil had knocked off the roof and part of the sides of the derrick, but there was a beam left at the top, against which the oil broke with a roar in its upward course, and which served in a measure to check its velocity. The derrick itself was seventy feet high, and the oil and the sand, after bursting through the roof and the sides, flowed fully three times higher, forming a grayish-black fountain, the column clearly defined on the southern side, but merging into a cloud of spray thirty yards broad on the other. A strong southerly wind enabled us to approach within a few yards of the crater on the former side, and to look down into the sandy basin formed round about the bottom of the derrick, where the oil was bubbling and seething around the stalk of the oil-shoot like a geyser. The diameter of the tube up which the oil was rushing was ten inches. On issuing from this, the fountain formed a clearly defined stem about eighteen inches thick, and shot up to the top of the derrick, where in striking against the beam, which was already worn half through by the friction, it got broadened out a little.

*Consular report, Buenos Ayres, March 20, 1883, E. L. Baker, Consul.

Thence continuing its course more than two hundred feet high, it curled over and fell in a dense cloud to the ground on the north side, forming a sand-bank, over which the olive-colored oil ran in innumerable channels towards the lakes of petroleum that had been formed on the surrounding estates.

"Now and again the sand flowing up with the oil would obstruct the pipe, or a stone would clog the course; then the column would sink for a few seconds lower than two hundred feet, to rise directly afterwards with a burst and a roar to three hundred feet. Throughout the previous day a north wind had been blowing, causing the oil and sand to fall in a contrary direction from that pursued while we were there. Some idea of the mass of matter thrown up from the well could be formed by a glance at the damage done on the south side in twenty-four hours—a vast shoal of sand having been formed, which had buried to the roof some magazines and shops, and blocked to the height of six or seven feet all the neighboring derricks within a distance of fifty yards. Some of the sand and oil had been carried by the wind nearly one hundred yards from the fountain, the sand-drenched roofs of the adjacent buildings showing how far the cloud of matter had extended. From this outer boundary, where the oil lay an inch or so deep on the ground, the sand-shoal rose gradually, until at the rim of the crater it was about twenty feet deep, the surface being hard and soddened, and intersected with small channels, along which the oil was draining off to the lakes. On the opposite side a new shoal was forming, and we could see the sand as it fell, drifting around the neighboring derricks and burying all the outhouses in the way.

"Here and there gangs of men were at work with wooden spades, digging and clearing channels round about the mouth of the well, to enable the oil to flow away. Their task was no easy or agreeable one. Upon their heads and shoulders oil and sand never ceased to fall, and they had to be careful to avoid being drawn into and engulfed in the vortex round the base of the crater. Luckily no stones of any size were being thrown up with the oil. Sometimes blocks weighing several pounds are hurled up from the depths below, and then it becomes a dangerous matter to approach a petroleum fountain. Standing on the top of the sand-shoal we could see where the oil, after flowing through a score of channels from the ooze, formed in the distance on lower ground a whole series of oil lakes, some broad enough and deep enough to row a boat in. Beyond this, the oil could be seen flowing away in a broad channel towards the sea.

"It may be asked how a magnificent oil fountain of this description should be able to make its owner a millionaire in one hemisphere and a bankrupt in another. The answer is simple enough. The fountain belonged to a small Armenian company, the "Droojba," having ground enough to establish a well upon, but nothing to spare for reservoirs. Consequently, all the oil was flowing away upon other people's property, and the amount subsequently caught and saved upon the waste lands afar off was being sold at such a low price as to be altogether inadequate to meet the claims for compensation from those whose houses and shops had been engulfed and their derricks hindered from working, by the sand thrown up from the well. Had the "Droojba" possessed plenty of land round about their well, to store the oil, they would not have been so badly off, but their well happened to be in the midst of several hundred estates covering the Balakhani Plateau, and hence the damage done ruined them.

"A feature in the American oil supply is, that while there are many wells yielding thousands of gallons of petroleum daily, the larger proportion give only hundreds. The richest well on record, I believe, has not

exceeded two hundred thousand gallons a day. At Baku the wells are nearly all of them what Americans would consider extremely copious ones. A well yielding only a few hundred gallons of oil a day a Baku firm would not consider worth working. This is not remarkable, seeing that the richest of the Baku wells has yielded two million gallons, or ten times the largest yield in America, in twenty-four hours.

"Flowing wells yielding from forty thousand to one hundred and sixty thousand gallons of oil every day, of rare occurrence in America, are quite common at Baku. The ordinary yield of the pumping wells is from ten thousand to twenty-five thousand gallons. It is common for these pumping wells to be worked for years, without the supply diminishing. Gospodin Kokereff has one which has already produced sixty million gallons of oil, and still continues to yield the same rate as at the outset. In Group VIII, is a flowing well belonging to the Baku Petroleum Company, which for two years has given a regular supply of forty thousand gallons daily from a depth of two hundred and fifty-two feet, without showing signs of exhaustion.

"In 1875 there was a third fountain in Group XIII, which spouted six hundred thousand gallons of oil every twenty-four hours. This belonged to the Company of Petroleum Participators, which has had a number of fountains in the course of its career. In 1874 the well, which was one hundred and ninety-six feet deep, and had been giving eight thousand gallons a day for some time, began to diminish. Boormeister, the German engineer, thereupon began to bore deeper to obtain a fresh supply. At two hundred and eighty feet he lost oil altogether, although plenty of gas came to the surface. At three hundred and fifteen feet he reached a bed of rock. This was so hard that he had to put on eight men to drill through it. Suddenly, on the twenty-sixth of October, the boring tool broke through the roof of the subterranean reservoir, and only one man was then needed instead of eight. To ascertain the cause of this sudden facility of working, the tool was withdrawn, when a small fountain of oil began to spout. This ceased after a few minutes, and then the gas began to roar, accompanied by a sort of explosion below, producing perceptible trembling of the earth round about the well. Afterwards oil and gas spouted at intervals. To keep both down a cap of half-inch boiler plate was placed over the tube; but in the night the oil suddenly broke it off, and began to spout forty feet high. The next day oil flowed at the rate of six hundred thousand gallons in twenty-four hours. Four huge lakes of oil were formed in the course of a month, the fountain not being closed over until the twenty-third of November.

"In 1877 Orbelovi Brothers had a great fountain from a well two hundred and ten feet deep, with a bore of ten and one half inches. The oil spouted slightly for a few days, and was then capped, but in making some improvements afterwards to the cap the pressure below burst it off the tube, and the petroleum issued with a fury nothing could check. In half an hour a reservoir holding forty thousand gallons was filled, and then the oil ran all over the place, forming a series of lakes. This fountain never spouted less than forty thousand gallons of oil a day, and sometimes attained one million two hundred thousand gallons. The total quantity of oil lost before the fountain was subdued was forty million gallons.

"A less striking but more valuable fountain, in 1877, was Meerzoeff's No. 5, in Group IX. The oil was first touched in 1876. The following spring, in deepening the well to three hundred and forty feet, the oil began to spout at the rate of eighty thousand gallons daily; the gravity being 0.865. After awhile it was successfully capped, and has since then given a per-

manent supply, amounting, up to the end of 1883, to sixteen million gallons.

"In 1878 the Caspian Company had a fountain from a depth of four hundred and sixty-two feet, giving one hundred and sixty thousand gallons daily. Altogether, the well spouted nearly ten million gallons of oil, of which six millions were sold for liquid fuel, and the remainder lost. Several remarkable fountains occurred the following year. One of these was in Group V, and belonged to Gospodin Mnatsakanoff. The well was two hundred and ninety-four feet deep, with a tube of number twelve iron, ten inches in diameter. The first month water and gas issued, then the sand started to spout, and played for four hours, followed by petroleum, bursting off the cap that had been successfully fixed. For one hundred and twenty days the oil spouted without cessation day and night, the average flow being one hundred and twenty thousand gallons daily—a record which the most copious well in America has never been able to maintain beyond two or three weeks. The total quantity of oil thrown up was fifteen million gallons, of 0.868 specific gravity. Of this, two million gallons were sold at half a copeck the pood, or between 7d. and 8d. the ton. Six hundred thousand gallons were sold to the Caspian Company for 800 roubles (£80) for the entire quantity—being used for fuel—and the remainder was burnt or allowed to sink into the soil. The tube, costing £500, was completely worn to pieces.

"In 1881 Gospodin Mnatsakanoff began deepening a twelve-inch well, which had exhausted the oil at two hundred and ninety-four feet. Having reached four hundred and thirty-four feet, oil was touched again. Great pains were taken to pack round about the tube, and fix a good cap to resist the pressure, but after a few days the oil broke through all impediments, and spouted. From September thirteenth to November first a total of three million three hundred and twenty thousand gallons issued, which was sold for 18,000 roubles (£1,800). The fountain was then placed under control. The following year, from February nineteenth to the end of the navigation season, the well was allowed to spout, and ejected eighteen million gallons, which was sold for 86,000 roubles (£8,600).

"In 1882 Krasilnikoff had two fountains. One was at Shaitan Bazaar, where a well was completed his engineers had been working upon at intervals since 1877. At a depth of three hundred and seventy-eight feet sand began to shoot up the tube, and after a time oil flowed at the rate of one hundred and sixty thousand gallons a day; the gravity being 0.850–51. Eleven days elapsed before a cap could be fitted; the loss during the interval being eight hundred thousand gallons. After the well was capped, it gave an abundant supply under firm control from the same depth for fifteen months. In the case of the second fountain the depth of the bore was five hundred and four feet, and the well spouted eighty thousand gallons a day. The total outflow was four million eight hundred thousand gallons, of which one million six hundred thousand were sold as fuel and the rest allowed to run to waste in lake Saboontchi. On the third of September the fountain caught fire and flared with terrific fury for ten days, when it was extinguished.

"At Shaitan Bazaar, Orbelovi Brothers had an enormous fountain at their No. 2 well. The engineers began boring it by hand in 1877, and completed it in 1881. The tube was twelve inches in diameter, diminishing to ten and one half. At a depth of four hundred and ninety feet oil was struck, and spouted four million gallons in a week. The stem of the fountain was over two hundred feet high, and a strong wind blowing at the time carried the oil spray five hundred yards to the office of the Baku

Petroleum Company, the manager of which lodged a complaint against Orbelovi Brothers, affirming that there was a serious danger of the establishment being set on fire. The oil flowed into a saline depression, and was there burnt to get rid of it. When the fountain ceased playing, the tube was found to be choked and ruined. Since then the well has remained unworked.

"In 1882 the Company of Petroleum Participators had a fountain at their No. 9 well, from a depth of four hundred and seventy-six feet. The tube was ten inches in diameter, and was composed of three-sixteenths inch iron. Its installation was effected under the supervision of Lentz, whose system of concreting round about the upper part of the well had proved so successful on a previous occasion. The fountain lasted twenty days, during which it carried to the surface eight million gallons. The average was four hundred thousand gallons a day. Of this one million six hundred thousand gallons were sold, one million two hundred thousand gallons conducted to a depression and stored, and five million two hundred thousand gallons lost. A cap was fixed on the sixth day. The well has since proved one of the most productive at Balakhani.

"The same year the Baku Mining Company had a fountain from a well four hundred and fifty feet deep. The tube was fourteen inches in diameter. In September it spouted four hundred thousand gallons in twelve days; in December one million two hundred thousand gallons in six days; and early in January, 1883, four hundred thousand gallons in two and one half days. Of the total of two million gallons, only six hundred and forty thousand gallons were sold, at $\frac{3}{8}$ copeck the pood (about 11d. the ton). The specific gravity of the oil was 0.867.

"A very remarkable fountain was Nobels' No. 9 well, which spouted from a depth of six hundred and forty-two feet one hundred and twelve thousand tons, or nearly thirty million gallons of oil, in four weeks. The height of the fountain was two hundred feet, and it threw the oil and sand for a distance of two hundred feet round about the derrick. Thanks to the extensive means of the company, only one million gallons were lost out of the thirty millions spouted; and of the latter, twenty million gallons were at once converted into kerosene and other products, and the remainder stored in reservoirs. After the pressure in the well had fallen, so that the orifice could be conveniently plugged by mechanical means sufficiently tight to resist the force below, the delivery of oil was still at the rate of six hundred barrels per hour. Another fountain, at their No. 25 well, threw up nearly two million gallons of oil daily, from a depth of five hundred and eighty-two feet. The pressure in the tube, ascertained by scientific instruments, was about two hundred pounds to the square inch. The well now yields a million gallons of crude oil per diem.

"But the great fountain of the year, and one whose renown penetrated to every part of Europe, was the Droojba. The maximum pressure of gas in previous fountains had not exceeded four atmospheres, but in the case of Nobels' No. 9 fountain and the Droojba, it exceeded thirteen. I have already described, in the opening part of this chapter, what a magnificent spectacle it was. Had the well been situated at the bottom of the monument, it would have spouted higher than the golden ball at the top. This "oil volcano" threw up—according to the estimate of the local experts, Mr. B., an American petroleum engineer, who chanced to be at Baku, the semi-official newspaper "Baku Isvestie," and a number of other authorities—four hundred thousand or five hundred thousand poods, or from one million six hundred thousand to two million gallons of oil every day for some time after the first outburst, which occurred on the first of Septem-

ber. In the middle of November it was still spouting two hundred and forty thousand gallons a day, and a three-inch iron boiler plate was ground to pieces in an attempt to divert the stalk of the fountain.

"With regard to the Droojba, in consequence of the prodigious outflow of oil, the crude article lost its value for the moment. Fedoroff filled his reservoirs with two million eight hundred thousand gallons of oil for 300 roubles, or £30. No one would give more than ¼ copeck the pood for what had previously fetched 2 or 3 copecks. Thousands of tons were burnt outside the district to get rid of it; thousands were led towards the Caspian; huge lakes of oil were formed near the well, and on one occasion the liquid suddenly flowed into a distant engine-house, and but for the promptness of the engineer in extinguishing his petroleum furnace the whole locality would have been ablaze. Houses were completely buried by the sand cast up with the oil. All efforts to stop the fountain on the part of Baku experts were fruitless. The indignation in Russia at the waste of oil was unbounded. At Baku all the well owners formed themselves into a congress to decide upon means for checking the fountain. Finally the Government of St. Petersburg was appealed to, and 2,000 roubles were assigned to equip two engineers to proceed to Baku. On the nineteenth of December the fountain suddenly stopped of its own accord—the pipe had got blocked—but after three hours it burst out afresh with increased violence. At length, on the twenty-ninth of December, Zorgé, a neighboring well-owner, succeeded in fixing a cap, and, in spite of a strong filtration round the tube, the oil remained under control the whole winter. Directly the outburst was stopped, a great disturbance took place in Nobels' No. 14 well, showing a connection of both with the same reservoir. The depth of the Droojba well was five hundred and seventy-four feet. The quantity of oil spouted was reckoned to have ranged between two hundred and twenty thousand and five hundred thousand tons, which, in America, would have yielded from £616,000 to £1,400,000 sterling.

"Such a prodigious outflow of oil was without parallel, not only in the annals of commerce, but in the records of science. The old eternal fire, and the blazing water at Baku, sink into insignificance compared with such a marvel. To the man of science the oil fountains of the Apsheron peninsula promise to become a source of permanent interest. Now the oil fields are more developed there are plenty of curious facts that need elucidation; one of the most striking of these is, that the fountains always play the fiercer after a north wind. Why this should be the case no one has yet satisfactorily explained.

"The owners of the Droojba, for want of capital to grip their good fortune, let a million sterling slip through their fingers. Gariboff, the engineer, appalled by the havoc, and vainly trying to check it, broke his heart; but had the Armenian firm been a rich European company, with the engineering resources of the west at its command, the result would have been very different. The Droojba oil well would have been more valuable than many a gold mine.

"Were there any guarantee that the oil would be as little wasted, as in the case of Nobels' wells, I should be the last to support the agitation that has been set on foot at Baku to place the fountains under government supervision. But when a single man pricks the earth, and wastes for ever fifty millions or one hundred millions gallons of good oil—enough to supply London for years—then there is an end to the common sense of the *laisser fairè* doctrine, and the State ought to step in and suppress the outburst at the owner's cost, even though that cost be confiscation."

The Russian oil of commerce has less color and odor than the American

oil. The American crude oil is superior to that of Russia in the larger percentage of illuminant; but on the other hand the Russian oil excels in the greater quantity of its lubricant.

PETROLEUM AS A FUEL.

Petroleum as a fuel has not as yet taken the place of coal in the United States of America, and from the present outlook it seems that it will be a long time before the succession takes place, at least in those parts where coal is so abundant as in Pennsylvania.

It requires one hundred and ninety-two gallons of petroleum to equal two thousand pounds of coal as a heat producer. With the present price of good steam coal in California the utilization of petroleum might prove an economy, and as the yield of the latter is becoming larger every day it is to be hoped that some one of our inventors may soon come forward with an appliance that will give more perfect combustion than anything we have now in use. The combustion at present is far from being satisfactory, the heat is irregular, and every absorbing material in and about the fire-rooms becomes saturated with the unconsumed volatilized oil; but petroleum has the advantage over coal in point of storage and the almost imperceptible percentage of ash.

On the Caspian and Black Seas petroleum fuel has entirely superseded coal, for the simple reason that in these sections there is an almost fabulous production of the oil, while the use of coal necessitates an importation.

For manufacturing purposes, in many instances where petroleum is used as a fuel, the articles are far superior to those made by the use of coal. The principal objection to former experiments made with the crude oil for steam purposes by the Central Pacific Railroad Company, was the vaporization and after-condensation, on the surroundings, of the unconsumed oil, and also the large amount of smoke and soot. This goes to prove that there was an imperfect combustion, due to the absence of heat and an insufficient supply of air; that is to say, the blast did not supply air in sufficient quantities to form a chemical unity with the carbon and hydrogen of the oil. The apparatus for supplying air and oil should be so constructed that the fuel and air would be so intimately mixed that the oxygen would unite with the carbon and hydrogen, the component parts of petroleum, and generate carbonic acid and water respectively.

In Russia, after the lighter oils are driven off, the crude material is used for the purpose of generating steam in the locomotive boilers and on the steamers; and beside getting up steam in much less time than with other fuel, the combustion is perfect even to the absence of smoke and soot. The oil is fed into the tender from tanks, at the different stations, and thence through pipes into the furnaces, where it meets the steam jets. The tanks on the tenders are so elevated that the oil reaches the furnaces by gravitation through conductors so regulated that the oil is fed slowly and in small quantities.

The following extract is taken from Executive Document, No. 131, House of Representatives, forty-ninth Congress, second session, from the reports of Lieutenant Wm. H. Schuetze, United States Navy, transmitted from the Department of State on the first of February, 1887, as follows: "Refuse petroleum has nearly supplanted wood as steamer fuel in all the Volga boats, estimated to be about two thousand in number."

As far as any information could be gathered on the preparation of a new fuel, in Russia, the following would answer as a general description: To the boiling oil not less than one nor more than three per cent of common

soap is added, and the ebullition continued until the soap is completely dissolved, which takes about half an hour, when the liquid suddenly turns into a waxy-like substance which hardens on cooling, and then the material can be pressed into bricks or any required form. It is difficult to kindle, but when once alight it gives off an intense heat, is slowly consumed without emitting any smoke, only leaving a percentage of ash in accordance with the amount of soda or potash contained in the soap used. It is further claimed that in comparison with anthracite coal, the latter is consumed in one third of the time, with one seventh of the heating power.

Experiments are being made by some of the manufacturers of Springfield, Ohio, with crude petroleum as a fuel in the manufacture of malleable iron, with fair possibility of success. The Champion Electric Light Company, at the same place, claims twenty per cent saving over coal by the use of petroleum.

Through the kindness of the Central Pacific Railroad Company, an examination into the methods of using petroleum as a fuel on their steamers was made, in company with Mr. Wm. McKenzie, Division Master Mechanic and Chief Engineer of Steamers, and much valuable information obtained, which is incorporated in this paper.

After the lighter oils are driven off, the residual, which is obtained from the Pacific Coast Oil Company's refinery, is used for steam purposes on the five following steamers, viz.:

Julia	400 working horse-power engine.
Oakland	998 working horse-power engine.
Piedmont	1,238 working horse-power engine.
Transit	800 working horse-power engine.
Thoroughfare	600 working horse-power engine.

The four first named use the oil regularly, but the Thoroughfare, being a freight boat, is only called into occasional use, therefore particular mention will only be made of those in constant service and the amount of material they consume per month of thirty-one days, and calculated in barrels of forty-two gallons each:

Residual or heavy oils consumed in 31 days by steamer Julia	600 barrels.
Residual or heavy oils consumed in 31 days by steamer Oakland	1,750 barrels.
Residual or heavy oils consumed in 31 days by steamer Piedmont	2,200 barrels.
Residual or heavy oils consumed in 31 days by steamer Transit	1,450 barrels.

The steamers Piedmont and Oakland, plying between San Francisco and Oakland, having the more powerful engines, and necessarily using a larger amount of fuel than the others, it would, perhaps, be better for the purposes of illustration to confine the description entirely to them.

The Piedmont makes between San Francisco and Oakland, in one day, eighteen and one half round trips, and thirteen and one half on the following day, or, in forty-eight hours, a total of thirty-two round trips. The engineer, Mr. H. Hughes, states that in a day of eighteen and one half round trips there is consumed a little over three thousand three hundred gallons of oil, and that previously when coal was used it required about forty tons of the latter for two days, or thirty-two round trips. Therefore, in agreement with the statement of the engineer, there would be consumed for each round trip something over one hundred and seventy-eight gallons of oil, or the equivalent in coal of one and one quarter tons; or, to be a little more explicit, about one hundred and forty-two gallons of oil would equal for the purpose of creating steam power, one ton of Carbon Hill coal.

On the Piedmont, as well as the Oakland, the feed tanks for supplying the furnaces are horizontal cylinders, and confined under the main deck,

and each having a capacity for a two days' supply of oil. As they are not sufficiently elevated to furnish enough pressure for a proper feeding of the oil, small pumps are used for the purpose of raising the oil from the tanks to from ten to twelve feet above the level of the burners; the latter it reaches by gravitation. Each tank is supplied with pipes running from the top through the hull of the boat on either side for the purpose of carrying off any gas that may be generated by the oil.

The engines are low pressure condensing engines running with thirty to thirty-five pounds of steam. Fresh water is used for the boilers and salt water for the condensers.

The Piedmont has two large boilers, with two furnaces to each boiler and three burners to each furnace.

At the burners the oil is atomized, or in other words, blown into the furnace as a fine spray, by a jet of dry steam which is fed by a redhot iron pipe passing through the furnace to the burners.

The construction of the furnaces and burners may be more fully understood by an examination of the accompanying illustrations. Figure 1 is a vertical longitudinal section of one of the furnaces.

Figure 2 is a vertical elevation of the fronts of the two furnaces belonging to one of the boilers, showing the positions of the oil and steam pipes, together with a horizontal view of the curved pipe E, in which the steam is superheated before it passes to the burners.

Figure 3 shows the details of construction of one of the burners, and the mode of its connection with the oil and steam pipes which run horizontally across the top of the furnace door openings.

Each burner A consists of two concentric tubes with a peculiar shaped mouthpiece. The inner tube, one fourth inch in diameter, is the transmitter of the superheated steam, and is surrounded by a second tube leaving an annular space one eighth inch wide between the two, which forms the conduit for the oil.

The conduit does not open directly into the furnace, but instead, the inner tube is contracted to about one eighth of an inch near the mouthpiece by swedging, and just beyond the contraction it is pierced with numerous small holes through which the oil passes from the annular space to the inside of the inner tube, where it meets and unites with the superheated steam before reaching the mouth of the burner.

The mouthpiece screws on to the outer tube, as shown in illustration A. Horizontally it is flattened and drawn out until the final opening through which the united steam and oil enter the furnace is a straight slit one and one half inches long and one sixteenth of an inch wide—flaring outwards at each end.

The cocks or valves which regulate the supply of oil and steam to the burners are peculiar in construction. By reference to Figure 3 it will be seen that in each case the valve-stem projects a short distance beyond the valve-seat into the pipe leading to the burner; and this portion of the stem is ground to fit the pipe in which it slides so closely that even when the valve is raised a short distance from its seat, no oil nor steam could reach the burners were it not for the following device: In the cylindrical surface of this projecting portion of the valve-stem are placed several little channels parallel with its axis, and of different lengths, one of them reaching entirely up to the valve-seat, while the others are successively shorter. The result is, that when the valve is but a little raised from its seat, only a very small quantity of oil or steam can pass to the burner through the longest one of these little channels; but as the valve is opened further the

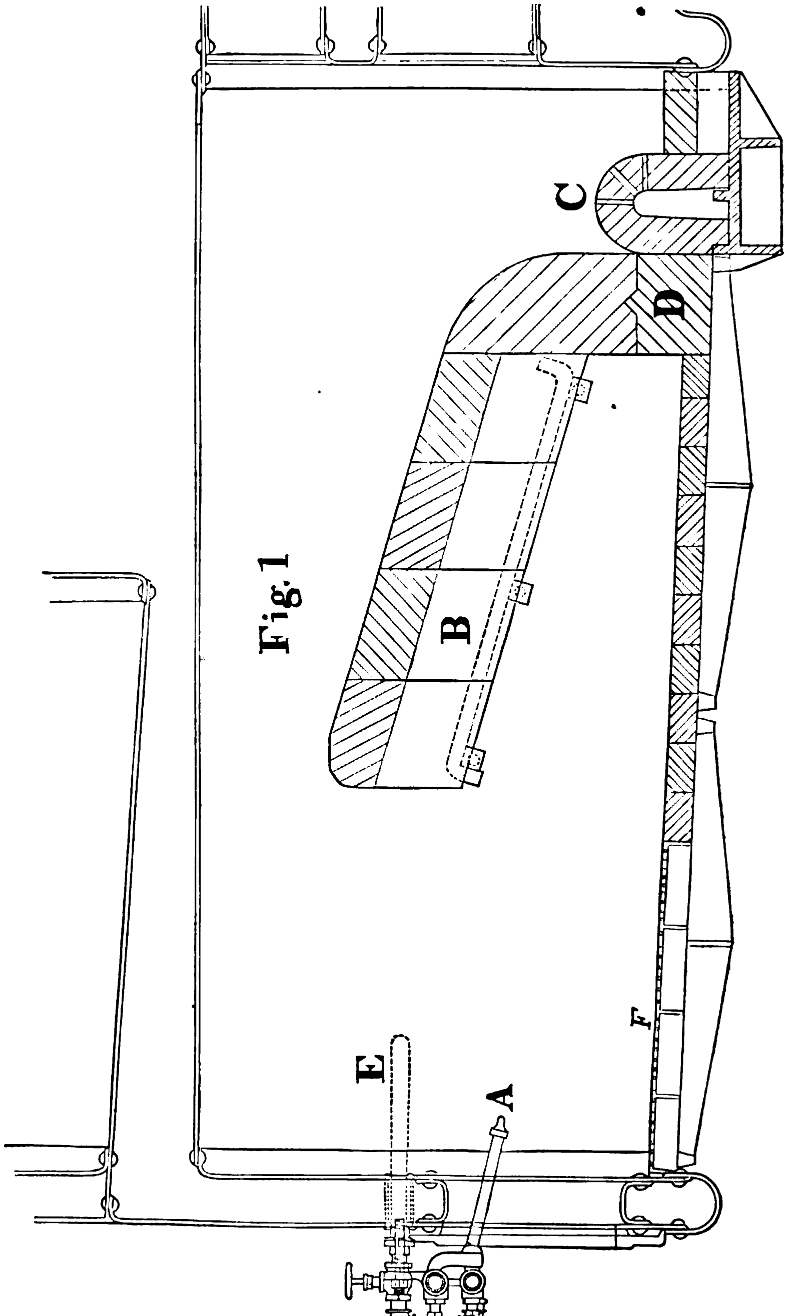


Fig. 1

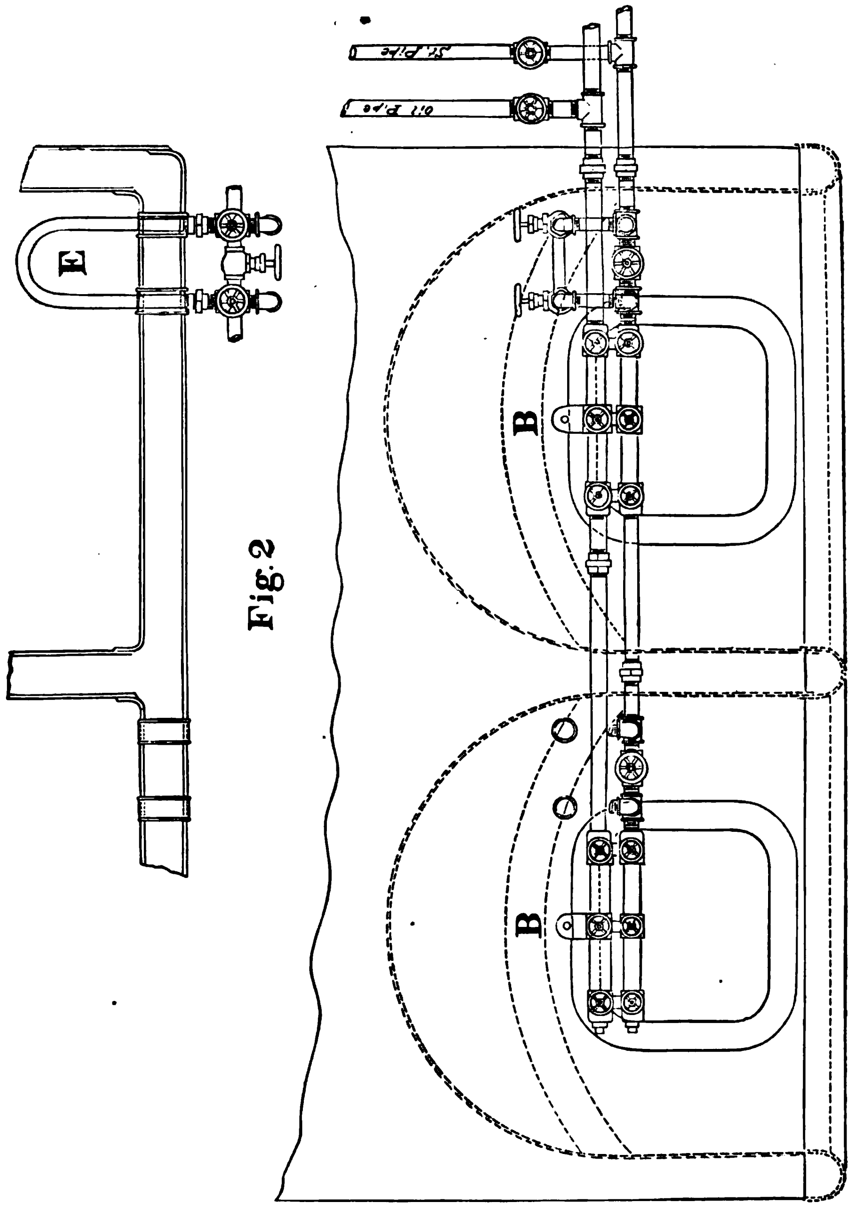


Fig. 2

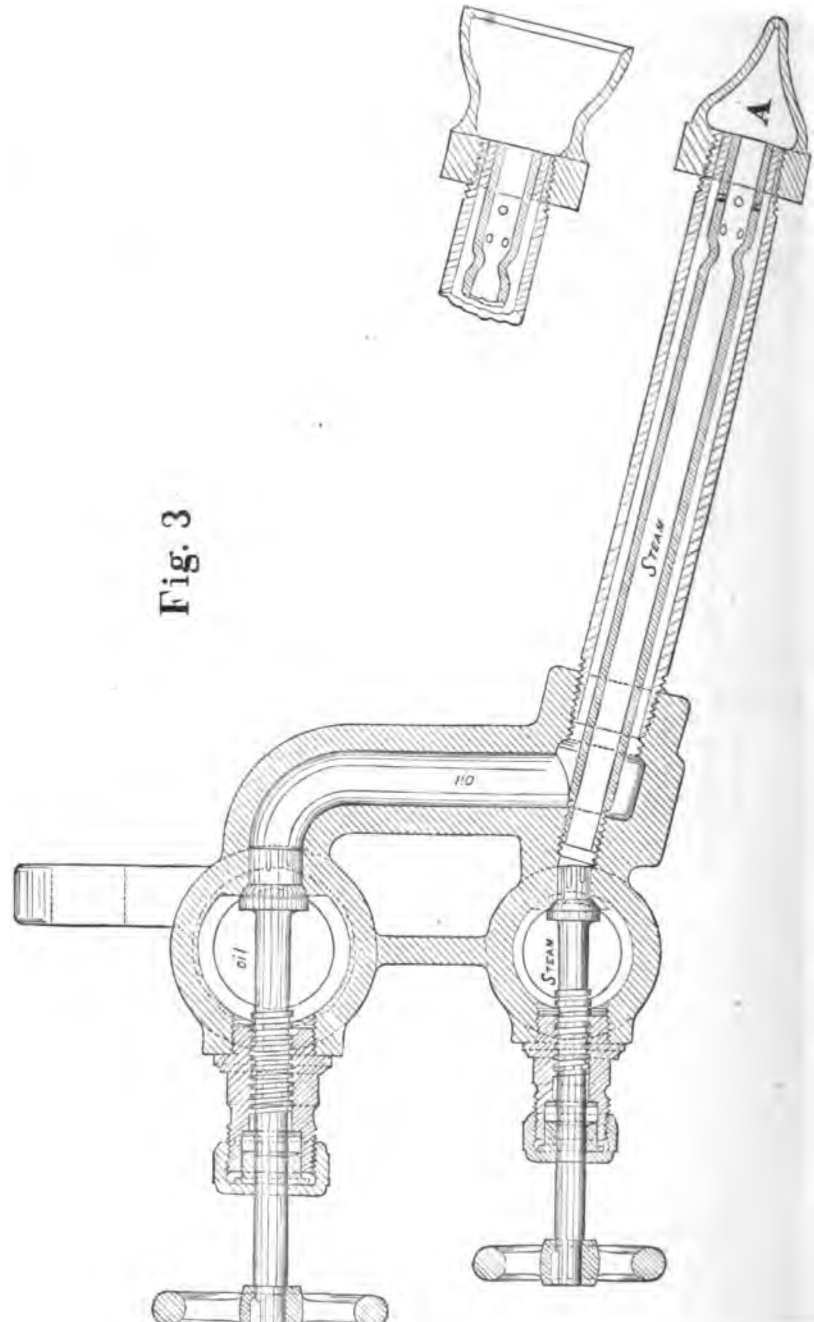


Fig. 3

quantity passing gradually increases till a second channel opens out, and later on a third one, and so on.

By this means the quantities of oil and steam passing to each burner can, at any moment, be regulated with the greatest nicety, and perfectly adjusted to each other.

There are three burners in position at the door opening, placed along the top of the furnace inclining slightly downward as they enter, and reaching from four to six inches inside.

Where the old grates, formerly used for burning coal, are replaced by those for burning oil, the latter (see F) are iron plates perforated with quarter inch circular holes.

The floors of the ash-pits are covered with a layer of sand and ashes mixed, for the purpose of absorbing any oil that may not be consumed, of which the amount is minimum.

The flame, a very long one, is at the mouth of the burner intensely hot and dazzling white, and almost smokeless.

The combustion, however, is not perfect, for the force of the blast propels small particles of the heavier oils through the flame to the walls of the furnace, where, if not consumed, they find their way to the ash-pit.

The air admitted through the grate, beneath the burners, is not sufficient for the oil's combustion, but by the following described very ingenious arrangement, the flame is met by a fresh supply of air and the consumption of the oil is made more nearly complete. A few feet in front of the burners a low, hollow arch of fire-brick runs transversely from side to side across the floor of the furnace, thus occupying a position similar to that of the fire-bridge in an ordinary furnace, but the flame does not pass immediately over the arch. On top of this arch rests the foot of another fire-brick arch, as shown in Figures 1 and 2, which spans the furnace transversely, and at the same time slopes upwards and backwards to within a short distance of the furnace door, where it stops. The inclination of the burners is such that the flame first strikes the floor of the furnace near the wall, as shown in D, Figure 1. It then turns upwards and backwards, doubling upon itself—passing up under the arch B to near the top of the furnace door, where it strikes and heats the curved tube E in which the steam employed to atomize the oil is superheated; then, curving over the top of the arch B, it passes forwards and downwards toward the flues. As the flame passes over the top of the hollow arch-bridge C, it meets another stream of air, which, coming from the interior of the arch-bridge C, and flowing out through numerous holes in the fire-brick forming the upper part of the arch, aids very materially to complete the combustion of the oils.

The first boiler flues through which the products of combustion pass are large ones, twelve to eighteen inches in diameter, but quite short. Under the central portion of the boiler comes another chamber, where further combustion can take place and more air be supplied if needed.

Southern Pacific Company, Office Auditor M. P. & M. Dept.,
San Francisco, February 16, 1886.

Col. C. F. Crocker, *Third Vice-President Southern Pacific Company:*

Dear Sir: Some days since you handed me a statement showing the amount of water evaporated to one pound of Carbon Hill coal under an ordinary stationary boiler; also amount evaporated to one gallon of petroleum on steamer Piedmont.

While it is hardly fair to make comparisons between a stationary boiler and boilers on a steamer, the figures given show very favorably for the Carbon Hill coal; though it would be interesting to know at what temperature the water was furnished the stationary boiler. I have no doubt but that it was furnished at, at least, 150 degrees Fahrenheit, while the water furnished the Piedmont boilers was at about 50 degrees Fahrenheit. This of course would cut a considerable figure in the calculations. We have no stationary boilers that are burning oil, therefore cannot make comparison on that basis; though scientific works on this subject give "the equivalent evaporative power of one pound of combustible under one atmosphere at 212 degrees Fahrenheit," as follows: coal, 14.62; oil, 28.50. I desire to submit the following, which may be of interest to you. From tests made on steamer Piedmont we find the following:

One ton of Carbon Hill coal evaporates ten thousand nine hundred and sixty gallons of water at a cost of $5 40, or $.00049 per gallon.

One ton of oil (two hundred and fifty gallons) evaporates twenty-two thousand six hundred and eighty gallons of water for $10, or $.00044 per gallon, which shows a saving in oil over coal of $.00005. In both cases the water was evaporated from about 50 degrees Fahrenheit.

The figures given below will show the relative cost for running steamer Piedmont with coal and oil.

In months of May, June, July, and August, 1885, when burning Carbon Hill coal, the cost was as follows:

2,476 tons of coal		$13,368 45
11 firemen		3,064 20
Total		$16,432 65
Average cost per month		4,108 16
Total miles run	17,843	
Cost per mile for fuel	$74\frac{92}{100}$ cents.	
Cost per mile for firemen	$17\frac{18}{100}$ cents.	
Total cost per mile run	$92\frac{10}{100}$ cents.	

In months of October, November, and December, 1885, and January, 1886, when burning oil, the cost was:

316,879 gallons oil		$12,845 04
6½ firemen		1,870 88
Total		$14,715 92
Average cost per month		3,678 98
Total miles run	17,275	
Cost per mile for fuel	$74\frac{35}{100}$ cents.	
Cost per mile for firemen	$10\frac{83}{100}$ cents.	
Total cost per mile run	$85\frac{18}{100}$ cents.	

By the use of oil the saving is $429 18 per month, or $5,120 16 per year, which is $10\frac{44}{100}$ per cent.

On steamer Thoroughfare the saving is greater than on steamer Piedmont, and on the steamer Solano about the same.

Yours truly,

N. H. FOSTER,
Auditor M. P. & M. Dept.

SOUTHERN PACIFIC COMPANY, OFFICE AUDITOR M. P. & M. DEPT.,
SAN FRANCISCO, October 26, 1887.

A. N. TOWNE, *Esq.*, *General Manager Southern Pacific Company:*

DEAR SIR: Inclosed please find statements showing comparison between coal and oil for steamers Transit, Oakland, Julia, and Piedmont. You will note that the saving in favor of oil for the—

Transit is	$9\frac{8}{10}$ per cent.
Oakland	$24\frac{43}{100}$ per cent.
Julia	$22\frac{38}{100}$ per cent.
Piedmont	$21\frac{24}{100}$ per cent.

Yours truly,

N. H. FOSTER,
Auditor M. P. & M. Dept.

TRANSIT.

May and June, 1887, with coal:

Miles run		5,157
Tons Carbon Hill coal, $764\frac{1}{2}$, at \$5	\$3,822 50	
Firemen, 12, at \$70	840 00	
		\$4,662 50
Cost per mile run, coal		$74\frac{12}{100}$ cents.
Cost per mile run, firemen		$16\frac{29}{100}$ cents.
Total		$90\frac{41}{100}$ cents.

August and September, 1887, with oil:

Miles run		5,181
Barrels fuel oil, $2,617\frac{8}{10}$, at \$1 40	\$3,664 92	
Firemen, 8, at \$70	560 00	
		\$4,224 92
Cost per mile run, oil		$70\frac{74}{100}$ cents.
Cost per mile run, firemen		$10\frac{81}{100}$ cents.
Total		$81\frac{55}{100}$ cents.
Percentage in favor of oil		$9\frac{8}{10}$

JULIA.

July, 1887, with coal:

Miles run		1,364
Tons Carbon Hill coal, $217\frac{3}{4}$, at \$5	\$1,088 75	
Firemen, 2, at \$70	140 00	
		\$1,228 75
Cost per mile run, coal		$79\frac{82}{100}$ cents.
Cost per mile run, firemen		$10\frac{26}{100}$ cents.
Total		$90\frac{8}{100}$ cents.

September, 1887, with oil:

Miles run		1,312
Barrels fuel oil, $555\frac{1}{4}$, at \$1 40	\$777 35	
Firemen, 2, at \$70	140 00	
		\$917 35
Cost per mile run, oil		$59\frac{25}{100}$ cents.
Cost per mile run, firemen		$10\frac{67}{100}$ cents.
Total		$69\frac{92}{100}$ cents.
Percentage in favor of oil		$22\frac{38}{100}$

PIEDMONT.

For months of December, 1886, and June, 1887, with coal:

Miles run		8,797
Tons Carbon Hill coal, 1,299¼, at $5	$6,496 25	
Firemen, 22, at $70	1,540 00	
		$8,036 25
Cost per mile run, coal		$73\frac{84}{100}$ cents.
Cost per mile run, firemen		$17\frac{51}{100}$ cents.
Total		$91\frac{35}{100}$ cents.

For months of August and September, 1887, with oil:

Miles run		8,995
Barrels fuel oil, 4,022½, at $1 40	$5,631 50	
Firemen, 12, at $70	840 00	
		$6,471 50
Cost per mile run, oil		$62\frac{61}{100}$ cents.
Cost per mile run, firemen		$9\frac{34}{100}$ cents.
Total		$71\frac{95}{100}$ cents.
Percentage in favor of oil		$21\frac{24}{100}$

OAKLAND.

July, 1887, with coal:

Miles run		4,540
Tons Carbon Hill coal, 618¾, at $5	$3,093 75	
Firemen, 11, at $70	770 00	
		$3,863 75
Cost per mile run, coal		$68\frac{14}{100}$ cents.
Cost per mile run, firemen		$16\frac{96}{100}$ cents.
Total		$85\frac{10}{100}$ cents.

September, 1887, with oil:

Miles run		4,419
Barrels fuel oil, 1,729¾, at $1 40	$2,421 65	
Firemen, 6, at $70	420 00	
		$2,841 65
Cost per mile run, oil		$54\frac{80}{100}$ cents.
Cost per mile run, firemen		$9\frac{51}{100}$ cents.
Total		$64\frac{31}{100}$ cents.
Percentage in favor of oil		$24\frac{43}{100}$

SOUTHERN PACIFIC COMPANY, OFFICE AUDITOR M. P. & M. DEPT.,
SAN FRANCISCO, October 6, 1885.

TIMOTHY HOPKINS, *Esq., Treasurer Southern Pacific Company:*

DEAR SIR: Replying to your favor of some days since, relative to the use of oil as fuel, I would respectfully submit the following.

During the year 1884, steamer Solano consumed:

5,014½ tons Empire coal, at $3 80		$19,055 10
2,190¼ tons Carbon Hill coal, at $5 50		12,046 30
Total for year		$31,101 40
Average cost per month	$2,591 79	
Miles run per month	5,973	
Cost per mile for fuel	$5 20	

During June, July, and August, 1885, she consumed:

3,715 barrels oil, at $1 70 per barrel		$6,315 50
Average cost per month	$2,105 16	
Miles run	1,372	
Cost per mile for fuel	$4 60	

This shows a saving in fuel of $486 59 per month, or $18\frac{7}{10}$ per cent.

The amount of oil burned per horse-power per hour on this steamer, is as follows:

Oil burned per day	1,620 gallons.
Average time burning oil	5.8 hours.
Oil burned per hour	279.31 gallons.
Indicated horse-power	1,702.
Oil burned per horse-power per hour	.1641 gallons.

Assuming the number of hours burning coal to be the same as oil, the result would be for coal during the year 1884:

Coal burned per day	39,479 pounds.
Time burning coal (assumed)	5.8 hours.
Coal burned per hour	6,807 pounds.
Indicated horse-power	1,702.
Coal burned per horse-power per hour	4 pounds.

Steamer Thoroughfare for five months, February to June, inclusive, 1884, consumed:

3,821¼ tons Ione coal, at $3 96	$15,132 15
92 tons Carbon Hill coal, at $5 50	506 00
Total	$15,638 15
Add six firemen at $70 per month each	2,100 00
Total for five months	$17,738 15
Average cost per month	3,547 63

For five months, February to June, 1885, inclusive, she consumed:

Oil costing	$8,635 98
Add two firemen at $70 per month each	700 00
Total for five months	$9,335 98
Average cost per month	1,867 19

This shows a saving for five months of 1885, over corresponding five months of 1884, of $8,402 17, or $1,680 43 per month, or $47\frac{36}{100}$ per cent.

Total saving for steamers Solano and Thoroughfare for month as above, $2,167 02, or $26,004 24 per year.

The boilers are so located on the steamer Solano that no saving in firemen can be made.

The space occupied for the storage of oil is about 50 per cent less than for coal.

The kind of oil used is the residuum after the volatile substances have been extracted.

Oil is adapted for use on locomotives. I believe it is now being used on locomotives in Russia.

It would hardly be practical here; however, as the supply of oil at present is limited, and I doubt whether it would be much cheaper in any event, considering the price we are now paying for coal, which is less than $7 per ton.

Yours truly,

N. H. FOSTER,
Auditor M. P. & M. Dept.

REFINING.

This is a process of distillation whereby the oils of different gravity, of which the crude petroleum is mechanically composed, are separated from each other at their respective points of vaporization; the various distillates being collected in separate receivers, and the coloring matter, together with the impurities, remaining in the retort.

This method of separating liquids of unlike gravity was patented in England nearly two centuries ago, therefore it is not, as many suppose, an offspring of the petroleum industry.

In the beginning the oil was refined at or near the wells, but since the improved method of transportation by pipes, the crude oil is conveyed to the nearest seaport town, and there submitted to fractional distillation.

The first operation in the refinery, after filling the stills, is fractional distillation; the second, treating with sulphuric acid; the third, agitation with an alkali.

The crude oil having been run into the still, a gentle fire is started, and the oils of a lighter gravity soon begin to vaporize and pass over into the receiver. The gravity of the oil should be taken from time to time as it comes over, and the heat raised according to the gravity of the distillate. When the distillate indicates a gravity of 60 degrees Baumé, the stream should be directed into the kerosene receiver, and there collected until the gravity has reached 38 degrees, when it is again changed and passed into another tank until no more distillate comes over. Connected with the still is a condenser of coiled or straight iron pipe, which is cooled by being kept in a tank through which flows a constant stream of water.

The first result, containing gasoline, naphtha, and benzine, is redistilled, and each fraction, as indicated by its specific gravity, gasoline 95 degrees to 80 degrees, naphtha 80 degrees to 65 degrees, and benzine 65 degrees to 60 degrees, collected in a separate receiver.

The second distillate, which is the illuminating oil, is conveyed to a lead-lined tank and thoroughly mixed by means of stirrers, or any effective method, with about two per cent by volume of sulphuric acid. If now allowed to remain at rest for a short time a thick dark tar-like liquid will settle beneath the oil. The dark sedimentary stuff is drawn off and the oil is well washed by agitating with water, then with a solution of soda or ammonia to destroy the acid, and lastly, again with water to remove every vestige of the chemicals.

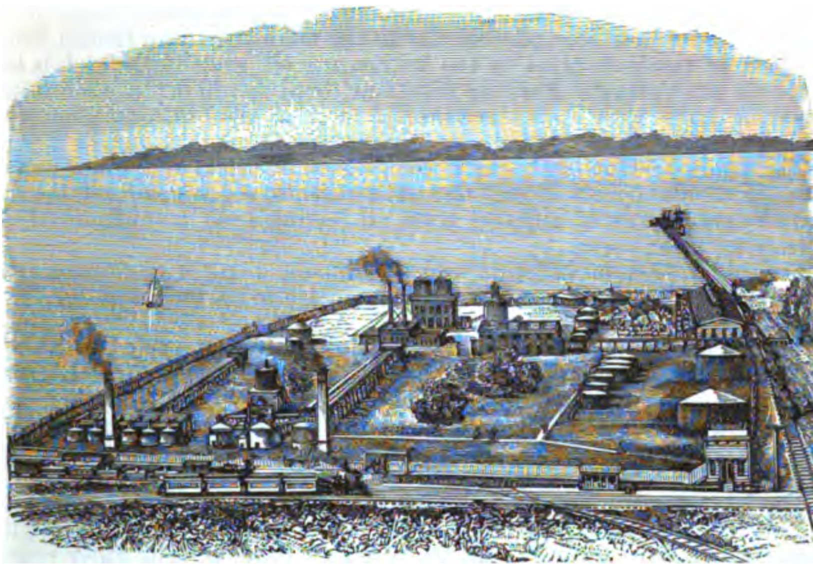
The third and last distillate, containing the lubricating oil and paraffine, is first treated with sulphuric acid, then with soda lye, and lastly distilled. The resulting distillate is set aside in a suitable vessel until the paraffine, by crystallization, separates from the lubricating oil.

REFINING AT THE PACIFIC OIL COMPANY'S WORKS AT ALAMEDA POINT, CAL.

Through the kindness of the managers of this company we are enabled to give the following description of their refinery, and the manner in which they conduct the process of refining.

The refinery of the Pacific Coast Oil Company, at Alameda Point, covers an area of fifteen acres, and is situated at the junction of the Southern Pacific Company, broad gauge system, and the South Pacific Coast railway system, narrow gauge, and also has communication to deep water by the Southern Pacific Company's wharf at Alameda Point.

The construction of this refinery was commenced in 1879, and additions have been made from time to time, as the increase of the business de-



PACIFIC COAST OIL COMPANY'S REFINERY AT ALAMEDA POINT.

manded. Refining was begun at these works in the fall of 1880, and has since been continuously prosecuted.

The storage capacity of the works consists entirely of tanks constructed in the most thorough manner of boiler iron, and are some forty in number, varying in capacity from twenty thousand barrels down to seventy-five barrels, making a total storage capacity of seventy-five thousand barrels. (It should be understood that a barrel of oil is forty-two gallons.)

These storage tanks comprise the storage for the crude oil and all its products, consisting of 86 degrees Baumé gasoline, 74 degrees naphtha, 63 degrees benzine, refined oil, lubricating oils, gas oil, and oil for fuel purposes.

In addition to the storage capacity above mentioned, there is one main still of a capacity of one thousand barrels; one continuous still of two hundred and fifty barrels daily capacity; two steam stills, four hundred barrels capacity each; one gasoline still, two hundred barrels; six tar stills for the manufacture of lubricating oils of a capacity of forty barrels each; and one lubricating oil still, one hundred barrels.

The stills are what are known as the "cheese-box" pattern, with corrugated bottoms which allow for contraction and expansion.

The main still is built with a globe top, with a dome above, six feet in height. This main still has twenty-five three-inch outlet vapor pipes, running into a sheet-iron pan, thence into the main condenser, two hundred and twenty-five feet in length, three feet in depth, and nine feet in width; and from the condenser into the "manifolds," and from the "manifolds" into the "observation boxes" in the receiving house, from whence the different products are conveyed by pipes to their different storage tanks.

The receiving house is built of brick; the "observation boxes" are of cast-iron with plate-glass faces, and the discharge pipes are connected with the observation boxes by gate-valves.

The tar or lubricating oil stills are connected by four-inch vapor pipes running into a sheet-iron pan, similar to the main still, from thence, being reduced to two-inch pipes to the lubricating oil condenser, which is two hundred feet in length, five feet wide and three feet in depth, then to the receiving house with appliances similar to those used in connection with the main still.

The pump and boiler house is constructed of brick, and contains two six-inch tubular boilers sixteen feet in length, also seven steam pumps and two air compressors of different sizes, all having been manufactured expressly for these works.

For connections, tanks, stills, and the different parts of the plant, there are many miles of pipes, varying from two inches to six inches in diameter, most of which are run under ground.

The "agitators" are three in number, built of iron and lined with sheet lead, the largest having a capacity of one thousand barrels, and the other two of one hundred and thirty barrels each.

There are two "bleaching" tanks of iron, with a capacity of one thousand barrels each, standing in a building of octagon shape, with glass sides and roofs.

The laboratory and water tanks are contained in a two-story building, the lower part of which is used for the laboratory, and the upper for the tanks, which have a capacity of five hundred barrels. The water supply needed for the works is obtained from four surface wells upon the premises, which furnish an ample supply; and at a moment's notice a stream of water can be directed to any part of the premises, from the steam pumps.

The lubricating house contains presses for pressing the paraffine oils, and settling tanks containing steam pipes, for the finishing of the oils. Said tanks are eight in number, with a total capacity of five hundred barrels. This building is two stories in height, the lower part being occupied by the presses, ice house, and barreling works for the lubricating department.

The warehouse is a building forty-eight by two hundred and ten feet, two stories in height, and contains cooper shop, can machinery, tin shop, and soldering house, and fillers for the illuminating oils, besides a storage capacity for five thousand cases. All the cans and cases used in the packing of refined oils are made upon the premises, the wooden shooks for the cases being brought from Truckee in carloads. The can machinery is the best of its kind in use, and has a filling capacity of two thousand cans a day, each can containing five gallons.

The office is situated on the northeast corner of the property, at the junction of the two railroads, and is a freight station for the Southern Pacific Company, and is also a station of the Western Union Telegraph Company, and the Bay and Coast Telegraph.

The main supply of oil refined at these works is brought in the cars from the wells in Los Angeles and Santa Clara Counties, the company having in its service sixty-five broad gauge cars and two narrow gauge cars. A four-inch pipe line also runs from the works to the Southern Pacific Company's wharf, and such oil as is brought from Ventura County, by steamer, is transferred to the company's tank-lighter, which has a capacity of five hundred and thirty barrels, and is pumped to the works through this line. The lighter is also used for the transferring of the products of the refinery to different points on the Bay of San Francisco.

METHOD OF REFINING.

The main still is charged with eight hundred and fifty barrels of crude oil, the only oil thus far used for this purpose being from the Pico Cañon and being of a gravity of thirty-nine degrees Baumé. Under this main still are eight burners, and the fuel used is the residuum of the oil. From this distillation there are five products, viz: "Gasoline stock," "benzine stock," "water white distillate stock," "standard white distillate stock," and a residuum which is used for fuel oil or lubricating stock. If used for fuel the lighter products are taken off until the residuum is of a gravity of twenty-four degrees Baumé and a fire test of two hundred and fifty degrees; this being the oil which the Pacific Coast Oil Company is furnishing the Southern Pacific Company as fuel for its ferry steamers. If run down to lubricating stock, the residuum is left of a gravity of twenty-one degrees Baumé.

The four lighter products above mentioned are then run through the steam stills, the products resulting therefrom being the following distillates, viz.: eighty-six degrees gasoline, seventy-four degrees naphtha, sixty-three degrees benzine, and a gas oil of from forty-six degrees to fifty degrees, a forty-six degrees water white illuminating and a forty-four degrees standard white illuminating. These distillates are then treated in the various ways necessary to produce the refined products of the same gravities, the illuminating distillates being agitated with an air blast and treated with acids which are drawn off and the oil washed with a solution of sal soda and water, after which the oil is sprayed into the bleacher, when it is ready for sale.

This product is a pure water white oil of about one hundred and fifteen degrees flash test, which, in burning qualities, is equal to any eastern oil, with the single exception of a slight tendency to smoke; this tendency to smoke, however, is not pronounced, except where poor burners are used.

The lighter products, gasoline, naphthas, and benzines, are in every way superior to any of eastern manufacture, being entirely odorless and having far superior drying qualities when used in paints.

According to the statement of the managers of the company, Pico Cañon, thus far, has been the only locality on this coast which has produced, in paying quantities, an oil of a sufficiently light gravity to pay for refining, there being little or no gasolines, naphthas, and benzines in the oils from other localities. In Moody Gulch, Santa Clara County, a limited production has been developed of an oil very similar to the product of the Pico Cañon wells. All of this oil is being refined at the Alameda Point Refinery. The production thus far has been small but promises well for future development. Prospecting in this vicinity is being steadily carried on.

CHEMISTRY OF PETROLEUM.

Petroleum is a complex hydrocarbon compound of the paraffine series—consisting of a mixture of several compounds, though not chemically united.

The crude mineral oils have a strong odor of bitumen, and, when unadulterated, a specific gravity ranging from .780 to 1.100; and in color, passing through the various shades, from an almost pure white to a decided black.

Petroleum is but little soluble in alcohol, and quite insoluble in water, but unites readily with chloroform, ether, and the hydrocarbons. It is a solvent for the fixed oils with the exception of castor oil. Petroleum fre-

quently contains nitrogen, oxygen, and sulphur, and in the thickened mass in San Luis Obispo County, gold has been found; of course the latter element is purely accidental. California petroleum contains a much larger percentage of sulphur, so far as known, than that found elsewhere. The average composition of petroleum is about 85 per cent of carbon and 15 of hydrogen, and it is highly combustible.

ASSAY OF CRUDE PETROLEUM.

Fractional distillation is the only proper method of arriving at the actual assay. The apparatus employed in the operation consists of a retort, copper preferred, connected with a condenser, and a graduated cylinder for receiving the distillate.

For distillation 500 c. c. of the crude material should be operated upon, and the fluid going over at the different temperatures collected in separate cylinders. Through the water jacket of the condenser a constant stream of cold water is kept flowing to condense the vapors arising from the retort. The graduated cylinder is placed at the lower end of the condensing tube, in a vessel of cold water, in such a position that the distillate will flow into it. A thermometer is fitted into the tubulure of the retort, by the means of a tightly fitting cork, for the purpose of marking the degrees of distillation of the various liquids. After the specific gravity, odor, and color are carefully noted, the process of distillation is commenced.

The flame is now applied to the retort, gently at first, and increased according to the requirements of each distillate, and until no more volatile matter is driven off.

The gravities of the different distillates are taken, by the hydrometer for liquids lighter than water, carefully noted, and the percentage calculated.

The following are the results of the investigation of some of the petroleum oils of California, obtained by Dr. W. D. Johnston, chemist of the State Mining Bureau:

SAN MATEO COUNTY.

Lane's Well—Purissima Cañon.

Crude oil	Specific gravity .855, about 34° B.
Distillate below 150° centigrade, 18 per cent	Specific gravity .759, about 54° B.
Distillate from 150°–300° centigrade, 44 per cent	Specific gravity .817, about 41° B.

Tunitas Well.

Crude oil	Specific gravity .799, about 45° B.
Distillate below 100° centigrade, 9.90 per cent	Specific gravity .707, about 68° B.
Distillate from 100°–125° centigrade, 17.30 per cent	Specific gravity .739, about 59° B.
Distillate from 125°–150° centigrade, 19.50 per cent	Specific gravity .761, about 54° B.
Distillate from 150°–200° centigrade, 17.20 per cent	Specific gravity .795, about 46° B.
Distillate from 200°–250° centigrade, 11.80 per cent	Specific gravity .837, about 37° B.
Distillate from 250°–300° centigrade, 6.00 per cent	Specific gravity .858, about 33° B.

SANTA CLARA COUNTY.

Well No. 4—Moody's Gulch.

Crude oil	Specific gravity .812, about 44° B.
Distillate below 100° centigrade, 9.40 per cent	Specific gravity .716, about 65° B.
Distillate from 100°–150° centigrade, 24.40 per cent	Specific gravity .756, about 57° B.
Distillate from 150°–200° centigrade, 17.10 per cent	Specific gravity .798, about 47° B.
Distillate from 200°–250° centigrade, 14.80 per cent	Specific gravity .836, about 39° B.
Distillate from 250°–300° centigrade, 3.60 per cent	Specific gravity .860, about 34° B.

VENTURA COUNTY.

Tar Creek—Pumping Well.

Crude oil	Specific gravity .833, about 28° B.
Distillate below 100° centigrade, 10.00 per cent	Specific gravity .720, about 64° B.
Distillate from 100°–125° centigrade, 6.80 per cent	Specific gravity .755, about 55° B.
Distillate from 125°–150° centigrade, 5.50 per cent	Specific gravity .777, about 50° B.
Distillate from 150°–200° centigrade, 9.70 per cent	Specific gravity .809, about 43° B.
Distillate from 200°–250° centigrade, 11.00 per cent	Specific gravity .856, about 33° B.
Distillate from 250°–300° centigrade, 7.10 per cent	Specific gravity .889, about 27° B.

Sespe, No. 2.

Crude oil	Specific gravity .859, about 33° B.
Distillate below 100° centigrade, 9.10 per cent	Specific gravity .700, about 70° B.
Distillate from 100°–125° centigrade, 9.20 per cent	Specific gravity .734, about 61° B.
Distillate from 125°–150° centigrade, 8.80 per cent	Specific gravity .762, about 54° B.
Distillate from 150°–200° centigrade, 11.80 per cent	Specific gravity .798, about 45° B.
Distillate from 200°–250° centigrade, 9.00 per cent	Specific gravity .822, about 40° B.
Distillate from 250°–300° centigrade, 8.00 per cent	Specific gravity .876, about 30° B.

Green Oil Well—Adams Cañon.

Crude oil	Specific gravity .853, about 34° B.
Distillate from 100°–125° centigrade, 7.80 per cent	Specific gravity .740, about 59° B.
Distillate from 125°–150° centigrade, 9.00 per cent	Specific gravity .762, about 54° B.
Distillate from 150°–200° centigrade, 18.00 per cent	Specific gravity .795, about 46° B.
Distillate from 200°–250° centigrade, 14.40 per cent	Specific gravity .832, about 38° B.
Distillate from 250°–300° centigrade, 10.00 per cent	Specific gravity .861, about 33° B.

Wild Bill Well—Adams Cañon.

Crude oil	Specific gravity .915, about 23° B.
Distillate below 150° centigrade, 9.20 per cent	Specific gravity .732, about 61° B.
Distillate from 150°–200° centigrade, 10.80 per cent	Specific gravity .813, about 42° B.
Distillate from 200°–250° centigrade, 8.00 per cent	Specific gravity .846, about 35° B.
Distillate from 250°–300° centigrade, 7.70 per cent	Specific gravity .880, about 29° B.

LOS ANGELES COUNTY.

Pico Well, No. 2.

Crude oil	Specific gravity .865, about 32° B.
Distillate below 150° centigrade, 10.60 per cent	Specific gravity .781, about 49° B.
Distillate from 150°–200° centigrade, 20.60 per cent	Specific gravity .800, about 45° B.
Distillate from 200°–250° centigrade, 16.20 per cent	Specific gravity .833, about 38° B.
Distillate from 250°–300° centigrade, 11.30 per cent	Specific gravity .858, about 33° B.

H. & S. Well, No. 3—Pico Cañon.

Crude oil	Specific gravity .846, about 35° B.
Distillate below 100° centigrade, 11.20 per cent	Specific gravity .723, about 62° B.
Distillate from 100°–125° centigrade, 9.30 per cent	Specific gravity .752, about 56° B.
Distillate from 125°–150° centigrade, 9.50 per cent	Specific gravity .775, about 51° B.
Distillate from 150°–200° centigrade, 13.60 per cent	Specific gravity .802, ybout 44° B.
Distillate from 200°–250° centigrade, 13.40 per cent	Specific gravity .841, about 36° B.
Distillate from 250°–300° centigrade, 8.80 per cent	Specific gravity .870, about 31° B.

Pico Well, No. 4.

Crude oil	Specific gravity .825, about 40° B.
Distillate below 100° centigrade, 9.10 per cent	Specific gravity .702, about 69° B.
Distillate from 100°–125° centigrade, 10.40 per cent	Specific gravity .739, about 59° B.
Distillate from 125°–150° centigrade, 9.30 per cent	Specific gravity .762, about 54° B.
Distillate from 150°–200° centigrade, 13.40 per cent	Specific gravity .787, about 48° B.
Distillate from 200°–250° centigrade, 13.90 per cent	Specific gravity .819, about 41° B.
Distillate from 250°–300° centigrade, 8.30 per cent	Specific gravity .847, about 35° B.

Pico Well, No. 9.

Crude oil	Specific gravity .836, about 37° B.
Distillate below 100° centigrade, 13.10 per cent	Specific gravity .710, about 67° B.
Distillate from 100°–125° centigrade, 6.50 per cent	Specific gravity .743, about 58° B.
Distillate from 125°–150° centigrade, 10.00 per cent	Specific gravity .764, about 53° B.
Distillate from 150°–200° centigrade, 13.60 per cent	Specific gravity .794, about 46° B.
Distillate from 200°–250° centigrade, 12.40 per cent	Specific gravity .829, about 39° B.
Distillate from 250°–300° centigrade, 7.20 per cent	Specific gravity .856, about 34° B.

Pico Well, No. 13.

Crude oil	Specific gravity .832, about 38° B.
Distillate below 100° centigrade, 9.70 per cent	Specific gravity .713, about 66° B.
Distillate from 100°-125° centigrade, 8.80 per cent	Specific gravity .742, about 58° B.
Distillate from 125°-150° centigrade, 6.00 per cent	Specific gravity .761, about 54° B.
Distillate from 150°-200° centigrade, 12.00 per cent	Specific gravity .783, about 49° B.
Distillate from 200°-250° centigrade, 11.20 per cent	Specific gravity .812, about 42° B.
Distillate from 250°-300° centigrade, 13.00 per cent	Specific gravity .840, about 37° B.

San Fernando Well—Pico Cañon.

Crude oil	Specific gravity .830, about 38° B.
Distillate below 100° centigrade, 17.30 per cent	Specific gravity .720, about 64° B.
Distillate from 100°-125° centigrade, 11.00 per cent	Specific gravity .753, about 56° B.
Distillate from 125°-150° centigrade, 9.40 per cent	Specific gravity .776, about 50° B.
Distillate from 150°-200° centigrade, 13.30 per cent	Specific gravity .803, about 44° B.
Distillate from 200°-250° centigrade, 10.60 per cent	Specific gravity .839, about 37° B.
Distillate from 250°-300° centigrade, 6.80 per cent	Specific gravity .865, about 32° B.

Puenta Tank—From Wells 3, 4, 5, 6.

Crude oil	Specific gravity .822, about 28° B.
Distillate below 100° centigrade, 10.60 per cent	Specific gravity .717, about 65° B.
Distillate from 100°-125° centigrade, 8.70 per cent	Specific gravity .747, about 57° B.
Distillate from 125°-150° centigrade, 7.70 per cent	Specific gravity .771, about 51° B.
Distillate from 150°-200° centigrade, 10.20 per cent	Specific gravity .803, about 44° B.
Distillate from 200°-250° centigrade, 7.20 per cent	Specific gravity .845, about 36° B.
Distillate from 250°-300° centigrade, 6.00 per cent	Specific gravity .881, about 29° B.

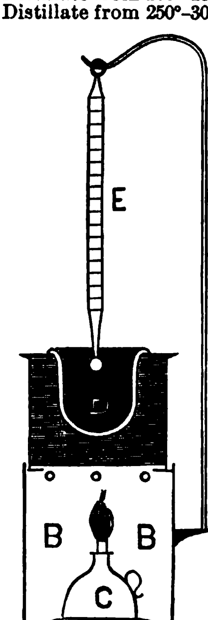
Little Moore Cañon, No. 1.

Crude oil	Specific gravity .910, about 24° B.
Distillate below 150° centigrade, 6.60 per cent	Specific gravity .757, about 55° B.
Distillate from 150°-200° centigrade, 11.20 per cent	Specific gravity .787, about 47° B.
Distillate from 200°-250° centigrade, 7.00 per cent	Specific gravity .821, about 40° B.
Distillate from 250°-300° centigrade, 8.80 per cent	Specific gravity .846, about 35° B.

MONTEREY COUNTY.

Cholame Valley Oil Company.

Crude oil	Specific gravity —, about —° B.
Distillate from 180°-200° centigrade, 9.40 per cent	Specific gravity .840, about 37° B.
Distillate from 200°-250° centigrade, 18.00 per cent	Specific gravity .867, about 31° B.
Distillate from 250°-300° centigrade, 10.40 per cent	Specific gravity .895, about 26° B.



Tagliabue Open Tester.

FLASHING POINT.

The flashing point is the temperature at which the oil gives off inflammable vapors; it differs from the burning point, in that the latter is the temperature at which the oil burns. The flashing point was adopted as a safeguard against the highly volatile oils which gave off their vapors at the ordinary temperature, and made them dangerous to use for burning in lamps.

The following is the American and British Petroleum Act governing the flashing point of petroleum oil, adopted in 1871:

"No petroleum oil should be used for burning in lamps which gives off inflammable vapors at any temperature below 100° F. (38° C.), when tested in an open cup, described in the schedule of the Act."

The most simple apparatus for determining the flashing point, is the Tagliabue Open Tester, of which the following is a description: A is a water-bath of brass, resting upon the stand B, and heated by the lamp C. D is a glass for holding the petroleum. E is the thermometer for taking the temperature of the flashing point. D is filled to the top with petroleum. The water in the bath is gradually heated; and from

time to time, until a flash is given, a lighted match is passed over the oil, about half an inch above it.

LOCATING FOR DRILLING, ETC.

It was believed in the early days of our petroleum excitement that where oil was found upon the surface, or seen issuing from the ground, that such points were the proper places to sink for the reservoirs; but experience has taught us the fallacy of early convictions, as the present producing wells have demonstrated. In passing over our oil belt it is noticeable that nearly all of the earlier workings, afterwards abandoned, were in close proximity to the exudations, or in ravines.

In boring for petroleum the prospector should not be discouraged, if at first he fails to meet with success in finding it in paying quantities, for it is beyond the possibility of man to locate, with any amount of certainty, a subterraneous reservoir.

The above is very remindful of the early days of gold and silver mining on the Pacific Coast, in connection with a celebrated litigation. There was a large array of scientific talent on either side, and the testimony pro and con was about equal. The Court was fast losing itself in the maze of scientific lore, and as the standing and integrity of the witnesses were beyond question, the Court was sorely puzzled. The pro experts were sure that a large body of rich ore would be encountered at such an angle, depth, and distance from the given point, whilst on the other hand, the cons were equally decided that sinking and drifting in another direction would be the correct thing. At this juncture an experienced miner was put upon the stand, and his testimony was about as follows: "I have listened with a great deal of interest to the scientific views of some of the gentlemen, and while granting that their geological theories may be correct, I cannot accept for a certainty the large body of rich ore, for in all of my observations and experience I have failed to find the man who had the ken to see an inch before the pick."

It does not follow that because wells have been sunk without finding oil that there is not any in the immediate vicinity, for instances have occurred on the oil belt of Pennsylvania whereof wells sunk but a few feet apart some have been dry and others have yielded handsomely. In fact, an instance is given by Mr. S. H. Stowell, editor of the "Petroleum Reports," where a well which was quite dry at first became a producer upon having the diameter of its bore increased about an inch.

Our oil men in the beginning had much to contend with, such as the high price of labor, costly transportation, and a paucity of knowledge, which, to use a very mild expression, bordered on ignorance. In the beginning the reports from the oil fields caused an excitement that lured many into the labyrinth of financial ruin. The agitation extended over the greater part of the State, but was more particularly concentrated on the fields within the counties of Santa Barbara, San Diego, and Los Angeles, where every foot of ground was located, even to the mountain tops, and wherever a patch of asphaltum was found there it was believed a fortune awaited the locator. Many were the shares of stock that were sold in finds that existed only in the fertile brains of the manipulators, and many of to-day regretfully remember the penalty of their rash precipitation in the petroleum days of 1864 and 1865.

That portion of Santa Barbara County, now Ventura, lying about twelve miles north of the town of San Buenaventura, was the busiest scene of the excitement. Through this section is a mountain ridge, with an altitude of

about two thousand feet, running nearly east and west, and some fourteen miles in length. The ground (as it is yet) was largely covered with asphaltum, through which in many places trickled little streams of oil, the latter intensifying the excitement and leading many to believe that an untold wealth awaited them for only a nominal expenditure. Our people were novices in the undertaking; they had not profited by lessons so dearly learned through similar exaggerated reports of fabulous gold finds; it was their wish to believe rather than discredit the magnified stories of the great reservoirs of oil—the outlet of which would be exposed by merely uncovering a few feet of the surface.

About this time, Professor Silliman, Jr., visited our coast in the interest of an eastern syndicate, and wrote of one great well whose exudation had turned into asphaltum which was one yard thick, covering an area of one square mile, and from which could be produced fourteen million five hundred thousand gallons of oil, one third of its weight in coke, and, throwing the coke to one side, the oil would bring to the company a "fabulous" sum of money. The Professor in mentioning the Ojai Ranch, told of the "twenty natural oil wells," some of large dimensions—how the oil escaped from its subterraneous prison, and came to the surface through a multitude of outlets, entered the streams, and flowed "miles and miles" away—and of the ranch's "almost fabulous wealth in the best of oil." This added fresh fuel to the flame of speculation. The stock was dealt in on the street corners; everybody wanted a well, and there not being enough to go around, those of more abundant imaginary resources were forced to locate them in their imagination, and willingly disposed of the stock to the unfortunate purchasers. But so sure as water will find its level, even so sure must such an abnormal state of affairs have an end. After long and weary waiting, no dividends were declared; in most cases the oil barrels lay empty upon the ground; assessment money was not forthcoming; the glowing reports from the fields of "fabulous wealth" began to be discredited, and just then the last smouldering ember of hope was extinguished by Professor Whitney, with the following few lines of opinion: "Within the last year the oil excitement of the Atlantic States has penetrated to the Pacific Coast, and the presence of a small portion of more fluid oil, in connection with the solid asphaltum, has led to unbounded hopes of a vast production of petroleum on the coast ranges of California, creating an excitement which has been skillfully made use of by unprincipled speculators, for their own purposes, by the creation of stock companies, with an immense number of shares, which have been disposed of to a credulous public; nearly the whole proceeds of their sale being clear profit to the promoters of these enterprises, while it is certain that even under the most favorable circumstances, the luckless stockholders will never receive even a moderate return for the money invested."

It took the enterprise many years to recover from the effects of this shock, but, nevertheless, it is now proven that the oil exists in paying quantities, for the undertaking has become a remunerative one.

The quality of petroleum varies considerably, not only that from different countries, but from different wells in the same vicinity. The purest natural product is said to be found at Baku, on the western shore of the Caspian Sea, in some instances being almost white, having just a perceptible yellow tint. The constituent parts of the oil are colorless, yet, with a few exceptions, as exuding from the earth it passes through the various shades, even to the black. Color and odor are indicative, alike, of impurities which most likely consist of organic matter or sulphuretted hydrogen, and when the material is found spread over the surface, around the springs,

in a pasty, sticky, or solid form, it has, in addition to the above pollution, become oxidized—in the latter case it is maltha or asphalt.

According to the decision of the New York Produce Exchange crude petroleum for commercial purposes is to be pure, natural oil, having a specific gravity of .782 to .800.

It is estimated that fifty-three thousand wells have been drilled in Pennsylvania and New York since the discovery of petroleum, at a cost of about $200,000,000. These wells have produced three hundred and ten millions barrels of oil, which were sold at the wells for $500,000,000, representing a profit of $300,000,000. The amount of oil exported is calculated at fourteen million eight hundred and thirty-five thousand nine hundred and seventy-four barrels.

The expense of sinking a well in California is considerably more than in Pennsylvania, but that the duration of its production is longer there does not seem to be any doubt.

PREPARING AND DRILLING.

The manner of procedure is best given in Mr. Carll's own language:

"'*Spudding.*'—With rig put in complete running order and conductor sunk to bedrock, the contractor is now ready to commence to drill. But the common boring tools are about sixty feet long, and therefore cannot be operated by the walking-beam in the usual way until the hole is deep enough to allow them to sink beneath the derrick floor. He must 'spud' the first sixty feet then without the aid of the walking-beam. To do this a short cable is run up over the crown pulley in the top of the derrick. One end of it is attached to the ring-socket and screwed to the auger-stem, the other is passed around the bull-wheel shaft two or three times and the end left free. The bull-rope is now put on and the engine started. A man stationed in front of the bull-wheels seizes the free end of the rope coiled around the shaft, a slight pull causes the coils to tighten and adhere to the revolving shaft, the auger-stem rises in consequence until it hangs suspended in the derrick, when it is swung over the hole and lowered through the conductor to the rock. The engine is kept running and the bull-wheels revolve all the while, but the man holding the shaft rope has full control of the tools. When he pulls on the rope the coils at once 'bight' the revolving shaft, the tools rise, when he gives his rope slack they fall, and so long as the coils remain loose upon the shaft it revolves smoothly within them and communicates no motion at all. Thus, then, alternately pulling and slacking the rope, this animated substitute for a walking-beam raises and drops the tools as much or as little as may be required, while the driller turns the drill to insure a round hole.

"*Driving pipe.*—When a conductor cannot be *dug* to the rock, and *drive-pipe* is to be inserted, a mall and '*guides*' must be provided for the purpose. The mall is made of any tough, hard log, that will dress fifteen or eighteen inches square and ten or twelve feet long. Two sides only are dressed: one end being rounded, and encircled by a heavy iron band to prevent its splitting, the other having a strong staple driven into it to tie the cable in. Two pairs of wooden pins are put in each of the dressed sides, one pair near the top, the other pair near the bottom. They are two inches apart, and two inches long, and serve instead of grooves in the mall—the guides fitting in between them.

"*To erect the guides*, draw a line on the derrick floor, through the center of the well and at right angles to the walking-beam; on this line place two two-inch plank perpendicularly, and stay them securely at the bottom and

from the sides of the derrick. They are to be fifteen or eighteen inches apart, according to the width of the mall to be used, and may be continued upward by adding two or three more plank, as circumstances require. They are strengthened by spiking a narrower plank on each side, leaving the center one projecting a couple of inches, to enter between the pins in the mall.

"After *spudding* awhile, as above described, to prepare the way for the drive-pipe, the drill is set aside—the pipe to be driven, armed at the bottom with a steel shoe, as shown in Figure 3, Plate XIV, is put in place; the mall is attached to the spudding cable and let down between the guides, where it is alternately raised and dropped upon the casing or drive-pipe by the man at the bull-wheels, precisely the same as in spudding. The casing used is of wrought-iron, screwed together in thimbles the same as tubing. A heavy cap of iron is screwed in the top when driving, to prevent it being injured by the blows of the mall.

"When two or three hundred feet of pipe are to be driven, as is frequently the case in some of our northern valleys, it requires a great deal of skill and judgment to put it in successfully. In these deep drivings, after a sufficient depth has been reached to admit of the introduction of a string of tools, they are put in and operated by the walking-beam in the usual way. The cable (a short one, furnished for the purpose), being coiled upon one end of the bull-wheel shaft, while the other end is left free to work the mall rope on. To facilitate the necessary changes which must be made every time the drill is stopped and pipe driven, the lower part of the guides are cut and hung on hinges some ten or twelve feet above the derrick floor, and when not in use may be swung up overhead out of the way of the workmen.

"'*Stringing' the tools.*—When a sufficient depth has been reached by spudding to admit of the introduction of a full 'string of tools,' the spudding machinery is abandoned.

"Now the coil of drilling-cable is rolled into the derrick and set upon end. The free end in the center of the coil is tied by a connecting cord to the rope just detached from the ring-socket, and by it drawn up over the crown-pulley and down to the bull-wheel shaft, where it is fastened. The bull-rope is put in place, the engine started, and the men carefully watch and guide the cable as it is wound, coil after coil, smoothly and solidly upon the shaft. When this is done the end of the cable depending from the crown-pulley is secured to the rope-socket, as above described, and the full set of tools are attached and swung up in the derrick. After carefully screwing up all the joints (the bull-rope having been unshipped), the tools are lowered into the hole by means of the bull-wheel brake, c. c.; the band-wheel crank is then turned to the upper center; the pitman is raised and slipped upon the wrist-pin, where it is secured by the key and wedges; the temper-screw is hung upon the walking-beam hook; the slack in the cable is taken up by the bull-wheels until the 'jars' are known to be in proper position. The clamps are brought around the cable (after a wrapper has been put on it at the point of contact), and securely fastened by the set-screw; the cable is slacked off from the bull-wheels, and the tools are now held suspended in the well from the walking-beam instead of from the top of the derrick, as before. Some fifteen or twenty feet of slack cable should be pulled down and thrown upon the floor to give free movement to the drill. When the drill is rotated in one direction for some time the slack coils around the cable at the well mouth; if it becomes troublesome the motion is reversed, and it uncoils. Only by this constant rotation of the drill can a round hole be insured.

"DRILLING.

"Having now made all the necessary connections, it only remains to give the engine steam, and the drill will rise and fall with each revolution of the band-wheel, and commence its aggressive work upon the rocks below.

"From this point downward the daily routine of the work is very monotonous unless some accident occurs to diversify it. Day and night the machinery is kept in motion. One driller and one engineer and tool dresser work from noon until midnight (the 'afternoon tour'), and another pair from midnight until noon (the 'morning tour.') Up and down goes the walking-beam, while the driller, with a short lever inserted in the rings of the temper-screw, walks round and round, first this way then that, to rotate the drill. He watches the 'jar,' and at proper intervals lets down the temper-screw as the drill penetrates the rock. When the whole length of the screw has been 'run out,' or the slow progress of the drill gives warning that it is working in hard rock and needs sharpening, he arranges the slack cable upon the floor so that it will go up freely without kinks, and informs the engineer that he is ready to 'draw out.'

"DRAWING THE TOOLS.

"After attending to the needful preliminaries, the driller throws the bull-rope upon its pulley, and quickly steps to the bull-wheel brake, while the engineer commands the throttle of the engine. The walking-beam and the bull-wheel are now both in motion, but at the proper moment one man stops the engine, and the other holds the bull-wheels with the brake just when all the slack cable has been taken up, and the weight of the tools is thus transferred from the temper-screw to the crown-pulley. This is a performance requiring experience and good judgment, for should any blunder be made a break-down must certainly result. To loosen the clamps on the cable, and unlock the pitman from the wrist-pin and lower it to the main-sill, is but the work of a moment. Dropping the pitman raises the end of the walking-beam with the temper-screw attached to it, and throws them back from their former perpendicular over the hole, so as to allow the cable and tools to run up freely without interference with them. Steam is now turned on again, and the tools come up. When the box of the auger-stem emerges from the hole, the engine is stopped. A wrench is slipped on the square shoulder of the bit, and the handle dropped behind a strong pin fixed for that purpose in the floor; another wrench is put on the shoulder of the auger-stem; a stout lever is inserted in one of a series of holes bored in the derrick floor in a circle having a radius a little less than the length of the wrench handle. It is brought up firmly against the upper wrench handle, thus making a compound lever of the wrench, and greatly increasing its power. Both men give a hearty pull on the lever, which 'breaks' the 'joint,' or, in other words, loosens the screw-joint connecting the bit with the auger-stem, so that the bit can be unscrewed and taken off by hand after it has been brought up above the derrick floor. The wrenches are then thrown off, steam is let on again, the bit rises from the hole. Now the driller throws off the bull-rope by operating a lever with one hand, while with the other he catches the bull-wheel with the brake, holding the tools suspended a few inches above the derrick floor. At the same instant the engineer shuts off steam, or else, suddenly relieved of its heavy work by unshipping the bull-rope, the engine would 'run away' with lightning

speed. It only remains now to hook the suspended tools over to one side of the derrick, and the hole is free for the sand-pump.

"While the driller is sand-pumping, the engineer unscrews the worn bit and replaces it by one newly dressed, so that there may be no delay in running the tools into the well again when sand-pumping is ended.

"*Sand-pumping.*—The 'line' to which the sand-pump is attached (as before described) passes up over a pulley near the top of the derrick, and thence down to the sand-pump reel, which is operated from the derrick by means of hand-lever V, and connecting levers U and T. While sand-pumping, the pitman remains disconnected, the bull-rope lies slack on its pulleys, and the band-wheel is kept constantly in motion. A slight pressure on lever V brings the friction pulley W in contact with the band-wheel, and the pulley immediately revolves, the slack sand-pump line is quickly wound up, and the sand-pump, which is usually left standing at one side of the derrick, swings out to the center and commences to ascend. Just now the lever is thrown back, and the connection between the friction pulley and the band-wheel being thus broken, the sand-pump commences to descend into the well by its own gravity. If it be likely to attain too great speed in its descent, a movement of the lever to bring the pulley either forward against the band-wheel, or backward against the brake-post previously mentioned, will quickly check it, and thus the speed may be regulated at will.

"As soon as the pump strikes bottom, additional steam is given to the engine, and the lever is brought forward and held firmly while the sand-pump rises rapidly from the well. The sand-pump is usually run down several times after each removal of the tools, to keep the bottom of the hole free from sediment, so that the bit may have a direct action upon the rock.

"*Drilling resumed.*—After the hole has been sufficiently cleansed, the sand-pump is set to one side, the drilling tools are unhooked, and swinging to their place over the well mouth, are let down a short distance by the brake, the wrenches are put on, and the lever is applied to 'set up' the joint connecting the replaced bit to the auger-stem; then removing the wrenches, the tools are allowed to run down to the bottom under control of the bull-wheel brake. Connections are now made as before, the driller commences his circular march, the engineer examines the steam and the water gauges and the fire, and then proceeds to sharpen the tool required for the next 'run,' and thus the work goes on from day to day, until the well is completed.

"THE JARS AND THEIR WORK.

"The jars are of the greatest importance to the driller, as they make known to him immediately any change in the working of the drill.

"J. F. Carll, in the Second Geological Survey of Pennsylvania, III, in a description of drilling tools says: The manner in which the jars perform their work may be best explained, perhaps, in this way: Suppose the tools to have been just run to the bottom of the well—the jars are closed as in figure C—the cable is slack. The men now take hold of the bull-wheels and draw up the slack until the sinker-bar rises, the 'play' of the jars allowing it to come up thirteen inches without disturbing the auger-stem. They watch for the coming together of the cross-heads, which will be plainly indicated by a tremulous motion communicated to the cable, and by the additional weight of the auger-stem. When the jars come together they slack back about four inches and the cable is in a position to be clamped in the temper-screw.

"If, now, the vertical movement of the walking-beam be twenty-four inches, when it starts on the up stroke the sinker-bar first moves; it rises four inches; the cross-heads come together with a sharp blow, and the auger-stem is picked up and lifted twenty inches. On the down stroke the auger-stem falls twenty inches, while the sinker-bar goes down twenty-four inches to telescope the jars for the next blow coming up. This is the theory of the movement, but of course in practice the *spring* of the cable in deep wells and the weight of tools make many modifications necessary. Some writers, in describing the manner of drilling, convey the impression that the sinker-bar is used as a *mall* to drive the auger into the rock; but this, we see, is entirely erroneous. A skillful driller *never* allows his 'jars' to strike together on the down stroke. They are only used to '*jar down*' when the tools stick on some obstruction in the well before reaching the bottom, and in fishing operations.

"An unskillful workman sometimes 'looses the jar' (especially if the well be deep and nearly full of water), and works for hours without accomplishing anything. The tools may be standing on the bottom, while he is playing with the slack of the cable, or they may be swinging all the time several feet from the bottom. If he cannot recognize the jar, he is working entirely in the dark; but an expert will tell you the moment he puts his hand upon the cable whether the drill is working properly or not.

"As the 'jar works off,' or grows more feeble, by reason of the downward advance of the drill, it is 'tempered' to the proper strength by letting down the temper-screw to give the jars more play.

"The *temper-screw*, L, forms the connecting link between walking-beam and cable, and it is 'let out' gradually to regulate the play of the jars, as fast as the drill penetrates the rock. When its whole length is run down, the rope-clamps play very near the well mouth. The tools are then withdrawn, and the well sand-pumped, and preparations made for the next 'run.' With the old fashioned temper-screw, a great deal of time was spent in readjustment, for it had to be screwed up thread by thread, by tedious revolutions of the clamps; but this delay is now obviated. The nut through which the screw passes is cut in halves, one half being attached to the left wing of the screw frame, the other half to the right wing. An elliptical band holding the set-screw L passes around the nut. It is riveted securely to one of the halves, and the set-screw presses against the other half to keep the nut closed. The wings are so adjusted that they spring outward and open the nut whenever the set-screw is loosened. To 'run up' the screw, the driller clasps the wings in his left hand, and loosens the set-screw; he then seizes the head of the temper-screw in his right hand, and, relaxing his grip upon the wings, the nut opens, when he quickly shoves the screw up to its place, again grips the wings and tightens the set-screw—the whole performance occupying less time than it has taken to describe it."

FROM THE STATISTICAL ABSTRACT OF THE UNITED STATES, 1886.

Quantity of Crude Petroleum Produced in and the Quantity and Value of Petroleum Products exported from the United States during each of the Years from 1864 to 1886, inclusive.

Year Ending June 30.	Production, a.		Exports.											
			Mineral, Crude (including all Natural Oils without regard to gravity).		Mineral, Refined or Manufactured.						Residuum (Tar, pitch, and all others from which the light bodies have been distilled).		Totals.	
	Barrels (of 42 gallons) Produced.	Gallons Produced.			Naphthas, Benzine, Gasoline, etc.		Illuminating.		Lubricating (heavy Paraffine, etc.).					
			Gallons.	Dollars.	Gallons.	Dollars.	Gallons.	Dollars.	Gallons.	Dollars.	Gallons, b.	Dollars.	Gallons.	Dollars.
1864	2,478,709	104,105,778	9,980,654	3,864,187	438,197	154,091	12,791,518	6,764,411	-----	-----	-----	-----	23,210,369	10,782,689
1865	2,424,905	101,846,010	12,293,897	6,868,513	480,947	173,943	12,722,005	9,520,957	-----	-----	-----	-----	25,496,849	16,563,413
1866	3,165,700	132,959,400	16,057,943	6,015,921	673,477	188,825	34,255,921	18,626,141	-----	-----	-----	-----	50,987,341	24,830,887
1867	3,591,900	150,859,800	7,344,248	1,864,001	224,576	34,175	62,686,657	22,509,466	-----	-----	-----	-----	70,255,481	24,407,642
1868	3,613,709	151,775,778	10,029,659	1,564,933	1,517,268	267,873	67,909,961	19,977,870	-----	-----	-----	-----	79,456,888	21,810,676
1869	4,046,558	169,955,436	13,425,566	2,994,404	2,673,094	445,770	84,403,492	27,636,137	c. 134,532	51,122	-----	-----	100,636,684	31,127,433
1870	4,411,016	185,262,672	10,403,314	2,237,292	5,422,604	564,864	97,902,505	29,864,193	c. 6,871	2,611	-----	-----	113,735,294	32,668,960
1871	5,558,775	233,468,550	9,859,038	1,971,847	7,209,592	746,797	132,608,955	34,138,736	c. 59,632	22,660	c. 155,474	14,770	149,892,691	36,894,810
1872	5,842,497	245,384,874	13,559,768	2,307,111	8,092,635	932,160	122,539,575	30,566,108	541,419	211,287	438,186	41,724	145,171,583	34,058,390
1873	7,242,343	304,178,406	18,439,407	3,010,060	9,743,593	1,487,439	158,102,414	37,195,735	748,699	277,966	781,074	79,566	187,815,187	42,050,756
1874	11,188,741	469,927,122	17,776,419	2,099,696	9,737,457	1,038,622	217,220,504	37,560,965	1,244,305	404,243	1,827,798	142,299	247,806,483	41,245,815
1875	10,083,828	423,520,776	14,718,114	1,406,018	11,758,940	1,141,440	191,551,933	27,030,361	1,173,473	313,646	2,752,848	187,103	221,955,308	30,078,568
1876	8,823,142	370,571,964	20,520,397	2,220,268	14,780,236	1,442,811	204,814,673	28,755,638	963,442	303,863	2,581,404	193,206	243,660,152	32,915,786
1877	10,822,871	454,560,582	26,819,202	3,756,729	15,140,183	1,816,682	262,441,844	55,401,132	1,601,065	497,540	3,196,620	317,355	309,198,914	61,789,438
1878	14,738,262	619,007,004	26,936,727	2,694,018	16,416,621	1,411,812	289,214,541	41,513,676	2,304,624	639,381	3,968,790	316,087	338,841,303	46,574,974
1879	16,917,606	710,539,452	25,874,488	2,180,413	15,054,361	1,258,780	331,586,442	35,999,862	2,487,681	655,468	3,307,038	210,726	378,310,010	40,305,249
1880	22,382,509	940,065,378	28,297,997	1,927,207	18,411,044	1,192,229	367,325,823	31,783,575	5,102,835	1,039,124	4,767,000	276,490	423,964,699	36,218,625
1881	25,805,363	1,083,825,246	39,984,844	3,065,464	17,292,310	1,693,975	332,283,045	34,317,695	4,852,203	1,054,064	3,247,860	184,411	397,660,262	40,315,609
1882, d	28,650,181	1,203,307,602	41,304,997	3,129,511	20,213,098	1,809,143	488,213,033	44,588,854	6,508,100	1,492,396	3,715,362	212,802	559,954,590	51,232,706
1883, d	26,662,808	1,119,837,936	52,712,306	3,914,941	17,070,537	1,302,286	419,821,081	36,926,574	10,182,342	2,326,632	6,145,356	442,646	505,931,622	44,913,079
1884	23,744,924	997,286,808	67,186,329	5,302,974	15,045,411	1,072,651	415,615,693	38,195,349	10,515,535	2,179,595	5,297,124	352,679	513,660,092	47,103,248
1885	21,750,619	913,525,998	81,037,992	5,903,833	15,822,853	1,272,290	458,243,192	40,074,827	13,002,483	2,632,883	6,561,660	374,114	574,068,180	50,257,947
1886	22,463,744	943,477,248	80,246,763	5,859,577	12,311,197	997,420	469,471,451	40,634,331	12,526,069	2,519,615	3,226,272	188,901	577,781,752	50,199,844

a. As a given number of gallons of refined petroleum represent the product of a larger number of gallons of crude petroleum, it is necessary to reduce the exports of petroleum to their equivalent in crude oil in order to arrive at a knowledge of the percentage of the total product of mineral oil exported. It has been ascertained, as the result of a careful computation, that the quantity of petroleum, and its distilled products, exported during the year ending June 30, 1878, was equivalent to 407,482,175 gallons of crude oil, or, in other words, that the exports of petroleum constituted about 66 per cent of the production. A larger percentage of the mineral oil product of the country is exported than of any other product, except cotton.

b. Barrels reduced to gallons, at the rate of 42 gallons to the barrel.

c. Estimated.

d. Figures of production for fiscal years 1882, 1883, 1884–5, furnished by S. H. Stowell, editor of "Stowell's Petroleum Reporter."

LOCATING AND PATENTING PETROLEUM CLAIMS.

The following circulars and correspondence will show the ruling of the General Land Office upon the subject of locating lands containing petroleum:

Petroleum claims may be patented under the Mining Act of May 10, 1872.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., January 30, 1875.

J. T. STRATTON, *Esq.*, *Surveyor-General*, *California*:

SIR: With your letter of twelfth of August last, you transmitted a copy of the report of William P. Reynolds, United States Deputy Mineral Surveyor, in regard to the Towsley Petroleum Mine, and you inquire whether land yielding petroleum may be patented under the Mining Acts.

It appears from the report, that D. A. Towsley *et al.*, made location and record of this claim in 1866; and that D. A. Towsley has had uninterrupted possession thereof since eleventh of March, 1865. That said claim yields five hundred gallons of petroleum daily.

Petroleum claims may be entered and patented under the Mining Act of May 10, 1872, upon full compliance with the provisions and requirements of said Act.

Very respectfully, your obedient servant,

S. S. BURDETT,
Commissioner.

[Copp's Land Owner, vol. 1, p. 179.]

MINES AND MINERALS—A. A. DEWEY.

Petroleum.—Land containing deposits of petroleum have been entered as placers and patented as such.

Commissioner McFarland to A. A. Dewey. Central City, Dakota Territory, March 31, 1882 (A. C. B.).

Lands containing deposits of petroleum have been entered as placers and patented as such.

Your inquiries are fully answered, therefore, by stating that lands of that character are subject to entry and disposal according to the law and regulations relating to placer claims.

[Copp's Land Owner, vol. 9, p. 51.]

STATE MINING BUREAU,
SAN FRANCISCO, October 25, 1887.

Hon. WM. A. J. SPARKS, *Commissioner United States General Land Office, Washington, D. C.*:

DEAR SIR: Will you kindly inform me if there has been any alteration of the ruling made by the Department, in locating land yielding petroleum, since the issue of the circular (No. 23), January 30, 1875, S. S. Burdett, Commissioner? (See Sickels' Mining Laws and Decisions, 1881, page 491.)

Very respectfully yours,

WM. IRELAN, JR.,
State Mineralogist.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., November 5, 1887.

WM. IRELAN, JR., *Esq.*, *State Mineralogist*, *San Francisco*, *Cal.*:

SIR: In reply to your inquiry of the twenty-fifth ultimo, you are informed that public lands containing valuable deposits of oil or petroleum are held to be subject to the operation of the United States Mining Laws relating to placer lands. Downey vs. Rogers, 2 L. D., 707, 4 L. D., 284, is among the later rulings on the subject.

Very respectfully,

S. M. STOCKSLAGER,
Assistant Commissioner.

ASPHALTUM AND ITS USES.

Asphaltum, like the mineral oils, is found in almost every part of the world in regular deposits, and sometimes in a pure state, but more frequently intermixed with fine quartz sand, earthy matters, or small pebbles; its melting point is about that of boiling water.

So far as known California is the only State in the United States of America in which the mineral is found in sufficient quantities to become merchantable.

The principal deposits in our State are in the counties of Santa Cruz, San Luis Obispo, Santa Barbara, Ventura, and Los Angeles.

Although in apparently inexhaustible quantities, it is of an inferior grade, but can be readily refined. It contains, in some instances, a large percentage of sand or fine gravel, from which it is easily separated by melting either with or without water; in either case the mechanical impurities fall to the bottom, and the refined material is skimmed or run off.

The mineral, on account of its mechanical impurities, is known commercially as bituminous rock; it is largely and favorably used for many purposes, though principally for paving, flooring, and roofing, and so popular has it become for these purposes that the demand for it is largely on the increase, and should the future price of transportation permit, there would be no doubt of it finding a ready market in the Eastern States. At present that which is used in the East is imported from several different countries, but more principally from Trinidad Island, where there is a large lake of it, nearly a mile in diameter, the material being hard along the shores but quite soft in and approaching the center.

The ancient Hebrews, the Assyrians, the Arabs, and Egyptians, were well informed as to its uses and important qualities. It is used as a varnish, as a water and an acid-proof paint, as a cement, as a preservative of wood, as an anti-erosive of metals, as a foundation for buildings when mixed with sand or carbonate of lime, and under the same conditions as beds for machinery. Paper wound spirally in several layers around a form and afterward coated with asphaltum, on being removed from the core makes good conducting pipes for various purposes. Houses in which the cellars are floored with asphaltum are more healthful than those in which the flooring is of wood or masonry—as the asphaltic covering is a protection from humidity. The immense anvil in Krupp's works at Essen, Prussia, which receives the stroke of a hundred and fifty ton hammer, rests upon a bed of asphaltum. A sidewalk of asphaltum was put down in Paris as early as 1838. In the same city there are at the present time over three million four hundred and forty-one thousand four hundred and

fifty-four square meters of sidewalks covered with it, and above ninety-eight thousand five hundred and fourteen square meters of streets paved with the same material.

In using asphaltum for paving it should be spread only upon a dry foundation; for if spread over a wet or damp bed it does not only, in a great measure, prevent its adherence to the material, but the generation of steam from the underlying damp layer, caused by the spreading and rolling of the hot material, pushes itself to the surface of the asphaltum, making innumerable small holes and blisters.

Illuminating gas softens asphaltum at every point of contact with it, therefore in cities having asphaltum paved streets, arrangements should be made to obviate the danger, for wherever there is a leaky gas pipe the pavement above will become soft and mushy.

LAYING OF ASPHALTUM ON PUBLIC THOROUGHFARES.

The following shortly described method is that used by the Santa Cruz Bituminous Rock Pavement Company, and to be seen in every-day operation in this city.

The material is broken into lumps not to exceed ten pounds in weight and thrown into an iron tank, where it is subjected to a treatment with steam until it becomes semi-liquid or of a pasty consistency. It is then spread evenly, two inches in thickness, over a prepared bed of concrete or other suitable material, and afterwards rolled with a steam roller weighing about ten tons.

The bed, or foundation, for receiving the asphalt dressing, is from six to eight inches in thickness, or, in some instances where broken stones are used, it is preferable to increase the depth to one foot. For sidewalks the foundation consists of broken stones, forming a layer about three inches deep. In either case, the bed, previous to receiving the asphaltic covering, is thoroughly tamped and rolled.

The cost of a first-class bituminous pavement per square foot is: a concrete bed of Portland cement, 16 cents per square foot; bitumen, two inches deep, 16 cents per square foot, making a sum total for a finished street of 32 cents per square foot. A foundation of macadam covered with two inches of bituminous rock costs about 23 cents per square foot. Sidewalks made after the method of their especial description costs from 9 to 11 cents per square foot.

The cost of mining and landing the bituminous rock of the above named company on the wharf at San Francisco is $6 per ton.

RESULTS OF ANALYSES OF CALIFORNIA ASPHALTUM.

The following analyses were made by Dr. W. D. Johnston, Chemist of the State Mining Bureau:

(Bituminous Rock.)—Mendocino County, California.

Volatile carbonaceous matter	11.60 per cent.
Fixed carbon	1.70 per cent.
Residue	86.70 per cent.
	100.00 per cent.

Residue: Coarse sand, containing—

Lime	2.10 per cent.
Magnesia	0.43 per cent.

Physical Characteristics.

The sand is very coarse, and consequently when fractured the readhesion is not as perfect as it should and would be if the sand were finer.

SANTA CRUZ COUNTY, CALIFORNIA—No. 1.

Volatile carbonaceous matter	18.16 per cent.
Fixed carbon	2.58 per cent.
Residue	79.26 per cent.
	100.00 per cent.

Residue: Fine sand, golden-colored mica, and a small amount of magnetite, containing 0.22 per cent of lime.

Physical Characteristics.

Blackish brown; after fracture does not reunite satisfactorily by moderate pressure at ordinary temperatures.

No. 2.

Volatile carbonaceeus matter	13.54 per cent.
Fixed carbon	1.90 per cent.
Residue	84.56 per cent.
	100.00 per cent.

Residue: Coarse-grained quartz, containing only traces of lime and magnesia.

Physical Characteristics.

Black, sticky mass; a coarse-grained quartz which readily reunites upon moderate pressure.

No. 3.

Volatile carbonaceous matter	46.20 per cent.
Fixed carbon	7.56 per cent.
Residue	46.24 per cent.
	100.00 per cent.

Residue: Fine-grained sand, containing $\frac{6}{10}$ of one per cent of lime, and a trace of magnesia.

Physical Characteristics.

Black and brittle, does not reunite on pressure at ordinary temperatures.

ADAMS & NICHOLLS' CLAIM, NO. 1 (RANCHO EL PISMO), SAN LUIS OBISPO COUNTY, CALIFORNIA, SEVEN MILES SOUTHEAST OF SAN LUIS OBISPO CITY.

Volatile carbonaceous matter	11.70 per cent.
Fixed carbon	2.46 per cent.
Residue	85.84 per cent.
	100.00 per cent.

Residue: Fine sand, containing only traces of lime and magnesia.

Physical Characteristics.

Black, compact, and tenacious mass.

No. 2.

Volatile carbonaceous matter	9.40 per cent.
Fixed carbon	1.20 per cent.
Residue	89.40 per cent.
	100.00 per cent.

Residue: Coarse sand containing 0.24 per cent of lime.

Physical Characteristics.

Black, firm, and compact sticky mass. The particles of sand are plainly visible.

No. 3.

Volatile and carbonaceous matter	12.80 per cent.
Fixed carbon	1.40 per cent.
Residue	85.80 per cent.
	100.00 per cent.

Residue: Chiefly coarse sand containing 0.14 per cent of lime.

Physical Characteristics.

A black, coarse-grained mass which, when broken, reunites firmly under pressure of the fingers.

JOHNSON AND WARDEN CLAIM, RANCHO CORRAL DE LA PIEDRA, CALIFORNIA, SAN LUIS OBISPO COUNTY.

Volatile carbonaceous matter	11.50 per cent.
Fixed carbon	1.10 per cent.
Residue	87.40 per cent.
	100.00 per cent.

Residue: Coarse sand containing 0.16 per cent of lime.

Physical Characteristics.

A brownish black mass, crumbling under pressure of the fingers.

P. C. HIGGINS' CLAIM, CARPENTERIA, SANTA BARBARA COUNTY, CALIFORNIA.

Volatile carbonaceous matter	14.10 per cent.
Fixed carbon	1.90 per cent.
Residue	84.00 per cent.
	100.00 per cent.

Residue: Fine sand containing traces of lime.

Physical Characteristics.

Soft, sticky, fine-grained black mass, crumbling under pressure of the fingers.

MOORE'S LANDING, SANTA BARBARA COUNTY, CALIFORNIA.—No. 1.—SEVEN MILES WEST FROM SANTA BARBARA.

Volatile carbonaceous matter	18.40 per cent.
Fixed carbon	3.00 per cent.
Residue	78.60 per cent.
	100.00 per cent.

Physical Characteristics.

Firm, compact, and brittle. Does not reunite by moderate pressure at ordinary temperatures.

MOORE'S LANDING.—No. 2.

Volatile carbonaceous matter	42.30 per cent.
Fixed carbon	8.00 per cent.
Residue	49.70 per cent.
	100.00 per cent.

Residue: Fine sand containing 1.20 per cent of lime and a trace of magnesia.

Physical Characteristics.

Firm, compact, glistening, and brittle. Does not reunite by moderate pressure at ordinary temperatures.

SAN FRANCISCO, CALIFORNIA.

Asphaltum pavement corner of Davis and California Streets.

Volatile carbonaceous matter	15.60 per cent.
Fixed carbon	2.50 per cent.
Residue	81.90 per cent.
	100.00 per cent.

Residue: Fine sand containing 0.3 per cent of lime.

LOCATING AND PATENTING ASPHALTUM CLAIMS.

From the following circulars it will appear that the General Land Office holds that deposits of asphaltum may be located under the Act of May 10, 1872:

Mines and Minerals.—Regulations governing the entry of lands containing borax and alkaline earths, sulphur, alum, and *asphalt.* Secretary Teller to Commissioner McFarland, January 30, 1883:

"My attention is called to the fact that these deposits, although valuable, are not of sufficient value to permit their being entered under the mining laws, if the recent circular approved by me September 22, 1882, and its amendment of December 9, 1882, is applicable to entries of lands containing borax and other similar valuable deposits. It was early determined by the department that the Act of May 10, 1872, which describes certain lands containing valuable mineral deposits, was applicable to lands containing deposits of borax, carbonate and nitrate of soda, sulphur, alum, and *asphalt;* and I believe that from the passage of the law until the present time, the definition of the term 'valuable mineral deposits' has been such as to include the minerals and alkaline substances named. I understand that entries of borate lands have been allowed under the provisions of the Act of 1872, and the regulations made in accordance therewith.

"It is the desire of the persons interested that the regulations which were in existence, having special reference to the application for patent for placer claims, namely, the circular of October 31, 1881, should be continued in force so far as they relate to deposits of borax, etc., as mentioned above.

"Believing that practical effect should be given to the mining laws of the United States, I am of the opinion that to apply the new regulations to such entries would result in excluding such lands from sale, and depriving the people of the benefit of the use of these natural deposits. I therefore direct you to permit the entry of public lands containing valuable deposits of borax, the carbonate and nitrate of soda, sulphur, alum, and asphalt in the States of California and Nevada, and the Territories of Arizona, Utah, and Wyoming—in which section of country, I am informed, the deposits are present—under the regulations of October 31, 1881.

"In addition, however, an applicant for patent for public lands containing deposits of borax, etc., as above, must affirmatively show that the lands entered are not valuable for any other purpose than the one for which application is made.

"It will, therefore, follow that the circulars of September 22 and December 9, 1882, are not applicable to entries of the lands thus described and excepted.

["Copp's Land Owner, vol. 9, p. 210."]

The following is an extract from the circular of Secretary Teller to Commissioner McFarland, in the case of Downey vs. Rogers, December 8, 1883:

"My letter of January 30, 1883 (Copp, February, 1883), considered the instructions of September 22 and December 7, 1882, in reference to lands containing deposits of borax, soda, alum, etc., and held that their application to such lands would result in the exclusion of the lands from sale. I therefore allowed their entry under the preceding regulations of October 31, 1881, in certain named States and Territories, requiring, however, an applicant for patent to show affirmatively that the lands were not valuable

for any purpose other than that for which application was made. Whether or not the same ruling should apply to oil lands is an undetermined question.

"That the facts may be first ascertained before deciding the same, I direct that you order an investigation as to the character and value of the lands in controversy and the improvements thereon, and that upon report thereof you transmit the same to this department.

["Copp's Land Owner, vol. 10, p. 307."]

NATURAL GAS.

It is doubtful whether natural gas will be found in our petroleum sections, to become of any great economic value, as the rocks in places turned up, as they are, on edge and fractured, preclude the possibility of securing gas in quantities approaching anywhere near the amount found in the Eastern States. The greater portion of the gas that may have existed in the underground reservoirs has long since escaped through the many natural outlets, or fissures, formed during the period when the rocks were turned up and faulted. In sections where the rocks lie in nearly a horizontal position and do not show signs of having been disturbed to any appreciable extent, there is a possibility of finding gas, but, unfortunately, such conditions are very scarce in our petroleum sections. Therefore, under the existing geological conditions, it would seem to be folly to expect that prospecting for gas, along our petroleum belt, would pay interest on the waste of time and money.

It is already proven, along the oil belt, by the scarcity of flowing wells, and the disturbed condition of the country rock, that natural gas, if existing at all, is not of sufficient quantities to warrant the expense of seeking.

Natural gas is widely spread over the Union, and there is scarcely a State where it has not been found; beside direct prospecting for it, it has been encountered in sinking wells for various purposes. The States producing the larger amounts of gas are Ohio, Pennsylvania, and New York—the latter being by far the greatest producer, and where, in the town of Fredonia, it was first used for illuminating purposes as early as 1821. The origin of natural gas is theorized in many different ways, but there seems to be but one conclusion to draw from the broad field of opinions, and that is that like petroleum, the enigma is apparently impossible of solution, and it is just as impossible to tell of the duration of the supply as it is of that of the mineral oils. As to its advantages over coal there is no questionable doubt, for it is a natural product furnishing a heating power which for the same purposes we have to obtain from coal by artificial means, and, beside, there are no ashes or soot, and but a slight percentage of loss in wear or other deteriorations in apparatus in which used.

It is stated that about three hundred millions cubic feet of natural gas are supplied daily to and around Pittsburg from one hundred and fifty wells.

The following is a schedule of charges in Pittsburg for natural gas for the various purposes enumerated, as given in "Pittsburg and its Industries:"

Iron and steel—	
Puddling, gross ton	$1 00
Heating, each heat, gross ton	40 to 60 cents.
Boilers, per month	$50 00 to $100 00
Total gas per ton iron, single heated, gross ton	$1 80 to $2 10
Sheet iron or steel, gross ton	$2 25 to $2 60
Hoop iron or steel, gross ton	$2 25 to $2 60
Open-hearth melting, gross ton	70 cents.
Crucible steel	50 cents.
Hammer furnaces, per day	$1 00 to $1 60
Glass—	
Flint, each ten-pot furnace, per month	$160 00
Each large glory hole, per month	30 00
Each lear, per month	25 00
Each steam boiler, per month	$35 00 to $50 00
Oil stills, per month	$35 00 to $100 00
Brick kilns and drying floors, per M.	$1 00
Fire brick, per M.	$1 00 to $1 40

Domestic use.—This is based on number of square feet heated, the basis being $10 a year for 15 square feet. The charge for heating stoves is $2 50 a month; for open grates, $2.

VALUE OF GAS AS A FUEL.

The Honorable J. P. Lesley, State Geologist of Pennsylvania, gives the following estimate of the value of gas as a fuel:

"One pound of coal weighs 25 cubic feet of gas. One pound of coal has a fuel value of 7½ cubic feet of gas. In 1885, 300 miles of gas mains to the factories and dwellings of and around Pittsburg, furnished heating power equal to 2,000,000 bushels of coal per month—1,000,000 tons of coal per annum. Before the end of 1885 one gas company in Pittsburg reported 335 miles of pipe of all sizes, displacing the use of about 10,000 tons of coal per day, or 3,650,000 tons per annum, the consumption growing rapidly.

"The waste at the wells being at first enormous, there was no economy at the works; but of late precautions have been taken to economize the supply. Probably 5,000 men will be dispensed with.

"The gas is odorless, because free from sulphur, etc. This purity must be taken into account in estimating its value as a fuel. It makes better iron, steel, and glass than can be made with coal gas or coal. It makes steam more regularly, because there is no opening or shutting of doors, and no blank spaces left on grate bars for the entrance of cold air. When properly arranged, its flow regulates the steam pressure, leaving the engine man nothing to do but watch the steam gauge. Boilers last longer, and fewer explosions result from unequal expansion and contraction when cold air strikes hot plates.

"The theoretical value of gas as compared with coals, is stated in the report of S. A. Ford, Chief Chemist of the Edgar Thomson steel works, as 210,069,604 heat units in 1,000 cubic feet of gas, weighing 38 pounds avoirdupois, while the same weight of carbon contains 139,398,896. Therefore 1,000 cubic feet gas=57.25 pounds of carbon, or coke (at 90 per cent carbon) 62.97 pounds, or bituminous coal, 54.4 pounds, or anthracite coal, 58.4 pounds.

"The gas thus compared with coal by Mr. Ford was a gas of average chemical composition. In point of fact gas from one well differs from gas of another well, and the gas from one and the same well varies in its chemical composition continually."

There is very little difference in the cost of boring for gas from that of boring for oil, when the general conditions are about the same.

Until 1884 there was very little use made of natural gas, excepting for illuminating purposes in and around Pittsburg, but after a few successful experiments it came into general use for manufacturing purposes.

COAL-LAND LAW AND REGULATIONS THEREUNDER.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE,
WASHINGTON, D. C., July 31, 1882.

GENTLEMEN: The following sections of the Revised Statutes provide for the sale of coal lands of the United States:

TITLE XXXII, CHAPTER SIX.

MINERAL LANDS AND MINING RESOURCES.

SEC. 2347. Every person above the age of twenty-one years, who is a citizen of the United States, or who has declared his intention to become such, or any association of persons severally qualified as above, shall, upon application to the Register of the proper land office, have the right to enter, by legal subdivisions, any quantity of vacant coal lands of the United States not otherwise appropriated or reserved by competent authority, not exceeding one hundred and sixty acres to such individual person, or three hundred and twenty acres to such association, upon payment to the Receiver of not less than ten dollars per acre for such lands, where the same shall be situated more than fifteen miles from any completed railroad, and not less than twenty dollars per acre for such lands as shall be within fifteen miles of such road.

SEC. 2348. Any person or association of persons severally qualified, as above provided, who have opened and improved, or shall hereafter open and improve, any coal mine or mines upon the public lands, and shall be in actual possession of the same, shall be entitled to a preference-right of entry, under the preceding section, of the mines so opened and improved; *provided*, that when any association of not less than four persons, severally qualified as above provided, shall have expended not less than five thousand dollars in working and improving any such mine or mines, such association may enter not exceeding six hundred and forty acres, including such mining improvements.

SEC. 2349. All claims under the preceding section must be presented to the Register of the proper land district within sixty days after the date of actual possession and the commencement of improvements on the land, by the filing of a declaratory statement therefor; but when the township plat is not on file at the date of such improvement, filing must be made within sixty days from the receipt of such plat at the district office; and where the improvements shall have been made prior to the expiration of three months from the third day of March, eighteen hundred and seventy-three, sixty days from the expiration of such three months shall be allowed for the filing of a declaratory statement, and no sale under the provisions of this section shall be allowed until the expiration of six months from the third day of March, eighteen hundred and seventy-three.

SEC. 2350. The three preceding sections shall be held to authorize only one entry by the same person or association of persons; and no association of persons, any member of which shall have taken the benefit of such sections, either as an individual or as a member of any other association, shall enter or hold any other lands under the provisions thereof; and no member of any association which shall have taken the benefit of such sections shall enter or hold any other lands under their provisions; and all persons claiming under section twenty-three hundred and forty-eight shall be required to prove their respective rights, and pay for the lands filed upon within one year from the time prescribed for filing their respective claims; and upon failure to file the proper notice, or to pay for the land within the required period, the same shall be subject to entry by any other qualified applicant.

SEC. 2351. In case of conflicting claims upon coal lands where the improvements shall be commenced after the third day of March, eighteen hundred and seventy-three, priority of possession and improvement, followed by proper filing and continued good faith, shall determine the preference-right to purchase. And also where improvements have already been made prior to the third day of March, eighteen hundred and seventy-three, division of the land claimed may be made by legal subdivisions, to include, as near as may be, the valuable improvements of the respective parties. The Commissioner of the General Land Office is authorized to issue all needful rules and regulations for carrying into effect the provisions of this and the four preceding sections.

SEC. 2352. Nothing in the five preceding sections shall be construed to destroy or impair any rights which may have attached prior to the third day of March, eighteen hundred and seventy-three, or to authorize the sale of lands valuable for mines of gold, silver, or copper.

RULES AND REGULATIONS.

Under the authority conferred by said Section 2351, the following rules and regulations are issued for carrying into effect the provisions of said law:

1. Sale of coal lands is provided for—

By ordinary *private entry* under Section 2347.

By granting a *preference-right* of purchase, based on priority of possession and improvement, under Section 2348.

2. The land entered under either section must be *by legal subdivisions*, as made by the regular United States survey. Entry is confined to surveyed lands; to such as are vacant, not otherwise appropriated, reserved by competent authority, or containing valuable minerals other than coal.

3. Individuals and associations may purchase. If an individual, he must be twenty-one years of age, and a citizen of the United States, or have declared his intention to become such citizen.

4. If an association of persons, each person must be qualified as above.

5. A person is not disqualified by the ownership of any quantity of other land, nor by having removed from his own land in the same State or Territory.

6. Any individual may enter by legal subdivisions as aforesaid any area not exceeding one hundred and sixty acres.

7. Any association may enter not to exceed three hundred and twenty acres.

8. Any association of not less than four persons, duly qualified, who shall have expended not less than $5,000 in working and improving any coal mine or mines, may enter under Section 2348 not exceeding six hundred and forty acres, including such mining improvements.

9. One person can have the benefit of one entry or filing *only*. He is disqualified by having made such entry or filing alone, or as a member of an association. No entry can be allowed an association which has in it a single person thus disqualified, as the law prohibits the entry or holding of more than one claim either by an individual or an association.

10. Lands that are sufficiently valuable for gold, silver, or copper to prevent their entry as agricultural lands cannot be entered as coal lands; and you will not allow any entry to be made under the above named provisions of law of lands valuable for their deposits of said minerals.

11. The present rules relative to "hearings to establish the character of lands," contained in General Land Office regulations of October 31, 1881, issued under the mining laws, will, as far as applicable, govern your action in determining the character of lands sought to be entered as coal land.

12. The price per acre is $10 where the land is situated *more* than fifteen miles from any completed railroad, and $20 per acre where the land is *within* fifteen miles of such road. The price of the land, however, must be determined by its distance from a completed railroad at the date of payment and entry irrespective of the preference-right of entry.

13. When application is made to purchase coal-land at the rate of $10 per acre you will in all cases require satisfactory proof that the land applied for is, at date of entry, situated more than fifteen miles from any completed railroad. This proof may consist of the affidavit of the applicant, or that of his duly authorized agent, corroborated by the affidavit of some disinterested credible party showing personal knowledge of the facts.

14. Where the land lies *partly within* fifteen miles of such road and in *part outside* such limit, the *maximum* price must be paid for all legal subdivisions the greater part of which lie within fifteen miles of such road.

15. The term "completed railroad" is held to mean one which is actually constructed on the face of the earth; and lands within fifteen miles of any point of a railroad so constructed will be held and disposed of at $20 per acre.

16. Any duly qualified person or association must be preferred as purchasers of those public lands on which they have opened and improved, or

shall open and improve, any coal mine or mines, and which they shall have in actual possession.

17. Possession by agent is recognized as the possession of the principal. The clearest proof on the point of agency must, however, be required in every case, and a clearly defined possession must be established.

18. The *opening and improving* of a coal mine, in order to confer a preference-right of purchase, must not be considered as a mere matter of form; the labor expended and improvements made must be such as to clearly indicate the good faith of the claimant.

19. These lands are intended to be sold, where there are adverse claimants therefor, to the party who, by substantial improvements, actual possession, and a reasonable industry, shows an intention to continue his development of the mines in preference to those who would purchase for speculative purposes only. With this view, you will require such proof of compliance with the law, when lands are applied for under Section 2348 by adverse claimants, as the circumstances of each case may justify.

20. In conflicts, where improvements have been or shall hereafter be commenced, priority of possession and improvement shall govern the award when the law has been fully complied with by each party. A mere possession, however, without satisfactory improvements, will not secure the tract to the first occupant when a subsequent claimant shows his full compliance with the law.

21. After an entry has been allowed to one party, you will make no investigation concerning it at the instance of any person except on instructions from this office. You will, however, receive all affidavits concerning such case and forward the same to this office, accompanied by a statement of the facts as shown by your records.

22. Prior to entry, it is competent for you to order an investigation, on sufficient grounds set forth under oath of a party in interest and substantiated by the affidavits of disinterested and credible witnesses.

MANNER OF OBTAINING TITLE.

23. When title is sought by *private entry* the party will himself make oath to the following application, which must be presented to the Register:

I, ——— ———, hereby apply, under the provisions of the Revised Statutes of the United States relating to the sale of coal lands of the United States, to purchase the ——— quarter of section ———, in township ———, of range ———, in the district of lands subject to sale at the land office at ———, and containing ——— acres; and I solemnly swear that no portion of said tract is in the possession of any other party; that I am twenty-one years of age, a citizen of the United States (or have declared my intention to become a citizen of the United States), and have never held nor purchased lands under said Act, either as an individual or as a member of an association; and I do further swear that I am well acquainted with the character of said described land, and with each and every legal subdivision thereof, having frequently passed over the same; that my knowledge of said land is such as to enable me to testify understandingly with regard thereto; that said land contains large deposits of coal and is chiefly valuable therefor; that there is not to my knowledge within the limits thereof any vein or lode of quartz or other rock in place bearing gold, silver, or copper, and that there is not within the limits of said land, to my knowledge, any valuable deposit of gold, silver, or copper. So help me God.

——— ———.

24. Thereupon the Register, if the tract is vacant, will so certify to the Receiver, stating the price, and the applicant or his duly authorized agent must then pay the amount of purchase money.

25. The Receiver will then issue to the purchaser a duplicate receipt, and at the close of the month the Register and Receiver will make returns of the sale to the General Land Office, from whence, when the proceedings are found regular, a patent or complete title will be issued; and on surrender

of the duplicate receipt such patent will be delivered, at the option of the patentee, either by the Commissioner at Washington or by the Register at the district land office.

26. This disposition at private entry will be subject to any valid prior adverse right which may have attached to the same land, and which is protected by Section 2348.

27. *Second.*—When the application to purchase is based on a priority of possession, etc., as provided for in Section 2348, the claimant must, when the township plat is on file in your office, file his declaratory statement for the tract claimed sixty days from and after the first day of his actual possession and improvement. Sixty days, exclusive of the first day of possession, etc., must be allowed.

28. The declaratory statement must be substantially as follows, to wit:

I,——— ———, do solemnly swear that I am ——— years of age, and a citizen of the United States (or have declared my intention to become a citizen of the United States), that I never have, either as an individual or as a member of an association, held or purchased any coal lands under the provisions of the Revised Statutes of the United States relating to the sale of coal lands of the United States, and I do hereby declare my intention to purchase, under the provisions aforesaid, the ——— quarter of section ———, in township ———, of range ———, of lands subject to sale at the district land office at ———, and that I came into possession of said tract on the ——— day of ———, A. D. 18—, and have ever since remained in actual possession continuously; that I have located and opened a valuable mine of coal thereon; and have expended in labor and improvements on said mine the sum of ——— dollars, the labor and improvements being as follows: (here describe the nature and character of the improvements) and I do furthermore solemnly swear that I am well acquainted with the character of said described land, and with each and every legal subdivision thereof, having frequently passed over the same; that my knowledge of said land is such as to enable me to testify understandingly with regard thereto; that there is not, to my knowledge, within the limits thereof, any vein or lode of quartz or other rock in place bearing gold, silver, or copper, and that there is not within the limits of said land, to my knowledge, any valuable deposit of gold, silver, or copper. So help me God.

——— ———.

29. When the township plat is not on file at date of claimant's first possession the declaratory statement must be filed within sixty days from the filing of such plat in your office.

30. One year from and after the expiration of the period allowed for filing the declaratory statement is given within which to make proof and payment; but you will allow no party to make final proof and payment except on notice to all others who appear on your records as claimants to the same tract.

31. A party who otherwise complies with the law may enter *after* the expiration of said year, *provided* no valid adverse right shall have intervened. He postpones his entry beyond said year at his own risk, and the Government cannot thereafter protect him against another who complies with the law, and the value of his improvements can have no weight in his favor.

32. Each claimant at the time of actual purchase must make affidavit as follows:

I, ——— ———, claiming under the provisions of the Revised Statutes of the United States, relating to the sale of coal land of the United States, the right of purchase to the ——— quarter of section ———, in township ———, of range ———, subject to sale at ———, do solemnly swear that I have never had the right of purchase under the aforesaid provisions of law either as an individual or as a member of an association, and that I have never held any other lands under its provisions; I further swear that I have expended in developing coal mines on said tract in labor and improvements the sum of ——— dollars, the nature of such improvements being as follows: ——— ——— ———: that I am now in the actual possession of said mines, and make the entry for my own use and benefit, and not directly or indirectly for the use and benefit of any other party; and I do furthermore swear that I am well acquainted with the character of said described land, and with each and every legal subdivision thereof, having frequently passed over

the same; that my knowledge of said land is such as to enable me to testify understandingly with regard thereto; that the same is chiefly valuable for coal; that there is not, to my knowledge, within the limits thereof, any vein or lode of quartz or other rock in place bearing gold, silver, or copper, and that there is not within the limits of said land, to my knowledge, any valuable deposit of gold, silver, or copper. So help me God.

—— ——.

33. The application, declaratory statement, and the affidavit required at the time of actual purchase—the forms of which are given above under paragraphs 23, 28, and 32—may be sworn to before any officer authorized by law to administer oaths, but the authority of such officer must be properly shown.

34. Any party duly qualified under the law, *after* swearing to his application or declaratory statement, may, by a sufficient power of attorney duly executed under the laws of the State or Territory in which such party may then be residing, empower an agent to file with the Register of the proper land office the application, declaratory statement, or affidavit required at the time of actual purchase, and also authorize him to make payment for and entry of the land in the name of such qualified party; and when such power of attorney shall have been filed in your office you will permit such agent to act thereunder as above indicated.

35. Where a claimant shows by affidavit that he is not personally acquainted with the character of the land, his duly authorized agent who possesses such knowledge may make the required affidavit as to its character; but whether this affidavit is made by principal or agent, it must be corroborated by the affidavits of two disinterested and credible witnesses having knowledge of its character.

36. Nothing in these regulations shall be so construed as to prevent a party from proving his citizenship or age, or establishing the status of the lands sought to be entered, in accordance with ordinary rules of evidence; and any proof regularly introduced for that purpose that would be competent in a Court or before a Commissioner charged with the ascertainment of facts, may be considered.

37. Assignments of the right to purchase will be recognized when properly executed. Proof and payment must be made, however, within the prescribed period, which dates from the first day of the possession of the assignor who initiated the claim.

38. The "Rules of practice in cases before the United States district land offices, the General Land Office, and the Department of the Interior," approved December 20, 1880, will, as far as applicable, govern all cases and proceedings arising under the sections of the Revised Statutes above quoted providing for the sale of coal lands of the United States.

39. You will report at the close of each month as "sales of coal lands" all filings and entries in separate abstracts, commencing with number *one*, and thereafter proceeding consecutively in the order of their reception. Where a series of numbers has already been commenced by sale of coal lands, you will continue the same without change.

N. C. McFARLAND, Commissioner.

To Registers and Receivers.

Department of the Interior, July 31, 1882.

Approved:

H. M. TELLER, Secretary.

PETROLEUM, ASPHALTUM,

AND

NATURAL GAS.

BY

W. A. GOODYEAR.

WILLIAM IRELAN, JR., *State Mineralogist:*

DEAR SIR: I herewith respectfully submit to you—

First—A report of my field work during the summer and autumn of 1887, devoted chiefly to the petroleums, asphaltums, and natural gas in the counties south of the Bay of San Francisco; and,

Second—A report upon the mineral coals of California.

Respectfully yours,

W. A. GOODYEAR.

PETROLEUM, ASPHALTUM, AND NATURAL GAS.

Contra Costa County.

At a certain locality on what is called "Oil Creek," not far from the corner between Sections 9, 10, 15, and 16 of Township 1 N., Range 1 E., M. D. M., there is a deposit of hydraulic cement rock which appears to be very large. There are, however, several different beds of it, which vary much in physical appearance and probably also in chemical composition. The chances would seem to justify a careful prospecting and testing of this deposit, which may yet prove valuable. Here, also, are two or three very small springs of cold, but strong sulphur water. Furthermore, a well was once drilled here to a depth, it is stated, of about four hundred feet for oil. Whether any oil was obtained here could not be learned with certainty, but there are rumors that this well was "salted," and certainly no oil is visible there now.

Fresno County.

Huron is the present terminus of the branch railroad running westerly from Goshen.

Tar Cañon is about twenty-five miles, by wagon road, southwesterly from Huron. The largest deposit of petroleum and asphaltum found in this cañon consists of a few very small springs (the largest only about three feet in diameter), which produce a very small quantity of water and black maltha, which latter has gradually hardened into a little bed of asphaltum of not more than five or six square rods in area. Barometer here reads one thousand two hundred feet. The place has recently been located as a "placer mine." There is considerable alkali, and probably also some sulphur in the water accompanying this tar. There is said to be a sulphur spring not far south of here. So far as can be seen, the rocks close by the main spring—the so called "Gibbes Spring"—seem to strike northwesterly, and dip northeasterly some 40° to 45°. But, overlying these rocks, and about three hundred or four hundred feet north of the main spring, a heavy and very prominent bed of hard sandstone crosses the cañon, striking nearly east and west, and dipping northerly about 75°. It is filled full of *Turritella* shells, which, however, are not easily gotten out whole. This hard sandstone stratum forms the prominent and ragged crest of a range of high hills for several miles in an east and west direction. About one fourth of a mile north of it are very heavy beds of fine clay shales.

Leaving Tar Cañon, after a few miles travel, we crossed over the ridge into Sunflower Valley. Here, on the south side of the crest, but close up to the head of the cañon going down into Sunflower Valley, and close alongside the road, at a point said to be about six miles east of Tar Cañon, and five miles north of Avenal Creek, there is another spot where there are two or three very small tar springs, of a dark brownish maltha, and also an area of two or three square rods of asphaltum. This locality is about the same distance south of the line of the comb of hard *Turritella* sandstone as that in Tar Cañon. This also has been recently located as a "placer claim." The aneroid here read nine hundred and fifty feet.

East of here, little can be seen of the hard sandstone comb. Came down from here through Sunflower Valley, and stopped for the night, October eighteenth, at Dagny's house at "Lone Cottonwood," which is on Sec. 2, T. 25 S., R. 18 E., M. D. M. Aneroid at Dagny's read five hundred and twenty feet.

Colonel W. N. Leete stated that he has some oil claims on Sections 7, 8, 15, 16, 17, 18, 20, 22, and 29, of T. 19 S., R. 15 E., M. D. M. But these localities were not visited for want of time.

Kern County.

Certain asphaltum and petroleum deposits in the northeastern foothills of the Coast Range, about forty-five miles westerly from Bakersfield, in Kern County, were visited on October ninth.

The old "Buena Vista Refinery" was a very small establishment, which has long since gone to ruin. It was located at some distance from the asphaltum deposits, and was on the N.W. ¼ of Sec. 13, T. 30 S., R. 21 E., M. D. M. At this locality there are several small springs of water, all of which seem to contain more or less sulphur. But one of them furnishes passable drinking water, while the others all contain a good deal of alkali.

On the southeast quarter of the same section, a well was once drilled by H. A. Blodgett, A. Weill, and others, of Bakersfield, to a depth of three hundred feet. At this depth they struck sand with oil, which soon rose about one hundred feet in the pipe. The rocks here are not well exposed, but near the well are much disturbed. It is a common opinion that this well would have paid if they had pumped it, which they never did. The oil, of a dark, brownish-black color, now stands in the pipe up to within about ten feet of the top of the well.

Mr. J. S. Hambleton and others own the N.W. ¼ of the N.W. ¼ and the S. ½ of the N.W. ¼ of Sec. 19, T. 30 S., R. 22 E., and the N.E. ¼ of the N.E. ¼ of Sec. 24, T. 30 S., R. 21 E., M. D. M.

On this tract they are drilling a well, which, on the ninth of October, was five hundred and eighty feet deep, having passed through the following strata: five feet surface soil; thirty-seven feet asphaltum; twenty-eight feet hard black shale, with sulphur water. At seventy feet struck first oil. Then had various colored shales to the depth of two hundred and seventy feet, where the next oil was struck. At four hundred and thirty-five feet passed through two feet of extremely hard rock. At four hundred and fifty feet, another stratum of oil, with soft shales to five hundred and sixty-five feet. Then five feet of shales and sandstones, mixed. The last ten feet was soft black sandstones. There is considerable gas at this well, and when visited, the oil was standing in the outer pipe, within about three feet of the surface of the ground.

At a point about nine hundred feet S. 20° W. from here, the bituminous shales in the gulch strike about N. 60° W., and dip about 80° southwesterly, and Mr. Hambleton says that this is about the general strike and dip in this vicinity wherever the rocks seem to be least disturbed. The exposures, however, are poor, and in many places there seems to have been much disturbance. The upturned edges of the rocks are almost everywhere covered with a more recent surface deposit, much of which is of an ashy consistence, so that one sinks into it ankle deep in walking over it. There is also much calcareous tufa about here, and considerable native sulphur mixed with the dirt in many places. The aneroid here read one thousand three hundred feet.

Large surface deposits of asphaltum are scattered along the hills here

for a distance of nearly half a mile in a northeast and southwest direction. About one thousand feet southwest of Hambleton's well, however, nearly all these indications of oil and asphaltum cease. Nevertheless, about half a mile southwest of his well, other parties some years ago sunk a well nine hundred feet deep, but got no oil nor gas.

On Sec. 28, T. 30 S., R. 22 E., another well was sunk five hundred feet deep, which was also a dry hole.

A short distance southwest of this last well, there are in the cañon quite a number of sulphur springs, some of which are warm, having a temperature of probably 100° to 110° F. These springs yield but very little water, which, however, is saturated with sulphuretted hydrogen, and also contains other combustible gases, and a very little oil.

Some distance further down the cañon, *i. e.*, to the north or northeast of the five hundred feet well, there are heavy beds of bituminous sandstone or asphaltum, interstratified with other comparatively recent horizontal beds high up in the cliffs on the left bank of the cañon.

The locality where the old Buena Vista Oil Company used to obtain their crude petroleum, is about three miles southeast of Hambleton's well, and about one thousand three hundred and fifty feet above the sea.

For a good description of these extensive deposits, as well as of the character and extent of the operations of the Buena Vista Oil Company, reference is here made to the Fourth Annual Report of the State Mineralogist, pages 296 and 297. Nothing has been done there for a number of years now, and there is really nothing new to add to the description there given.

At a point some five or six miles northeast of Sumner, near the center of Sec. 2, T. 29 S., R. 28 E., M. D. M., where the Kern River runs N. 30° W., magnetic, the bluffs on the left bank of the river are composed of very recent strata, which lie nearly horizontal, and are forty to fifty feet high. This is at the head of Mr. T. A. Means' ditch, nearly opposite to the place of Mr. R. T. Norris, on the other side of the river.

Here, in the ditch, only one or two feet above the present level (October twelfth) of the water in the river, there is considerable gas bubbling up, accompanied by some green oil, which forms a scum on the water. The upper portion of these bluffs is coarse sandstone, with some gravel intercalated. But the lower beds, so far as exposed in the ditch, are a soft clay-rock, which rapidly disintegrates on exposure to the air.

At a locality about one mile southwesterly from here and close to the line between Sections 3 and 10, in the same township, the river runs about due west. And here the horizontal sandstones in the bluffs on the right—*i. e.*, north—bank of the river are bituminous, and are overlaid by a bed of gravel five to ten feet thick. In some places, however, the bituminous sandstones are directly overlaid by a body of clay, which is sometimes ten feet or more in thickness.

Also, in the bed of Kern River itself, close to Mr. Means' house, he states that he once dug a little hole, not more than two or three feet deep, in the loose sand for water, and that the water which came into it was covered with a film of oil. This is about five miles from Sumner, and close by the head of the Beardsley ditch.

A little above Mr. R. T. Norris' house, on the right bank of the river, close to the water's edge, in the sands, there is a little seepage of oil and a little gas bubbling up; this is on Section 2. Here the hills on the north side are about one mile distant from the river, while on the south side the bluffs come down to the river bank.

Mr. Norris is now (October thirteenth) washing the gravel near the

river here for gold, but he has not yet cleaned up, and therefore does not know how it will pay.

In a little hole dug here for clean water, within three feet of the water's edge on the right bank of the river, and not more than two or three feet deep, the water was not drinkable, and was and is covered with a thin scum of oil. Also, close to Mr. Norris' house, a man once dug a well about fifteen feet deep for water, which he got. But just before striking the water, he struck such a quantity of gas that he narrowly escaped with his life.

Mr. Norris also tells me that about six miles above his place there is, on the left bank of the river, and about three hundred feet from it, a very strong, cold sulphur spring. Mr. John Barker lives about ten miles farther up the river than Mr. Norris, and Mr. W. R. McMurdo, County Surveyor of Kern County, states that about three miles above Mr. Barker's, and just at the mouth of the cañon, properly so called, of Kern River, there is an oil spring where the oil can be seen floating on the water.

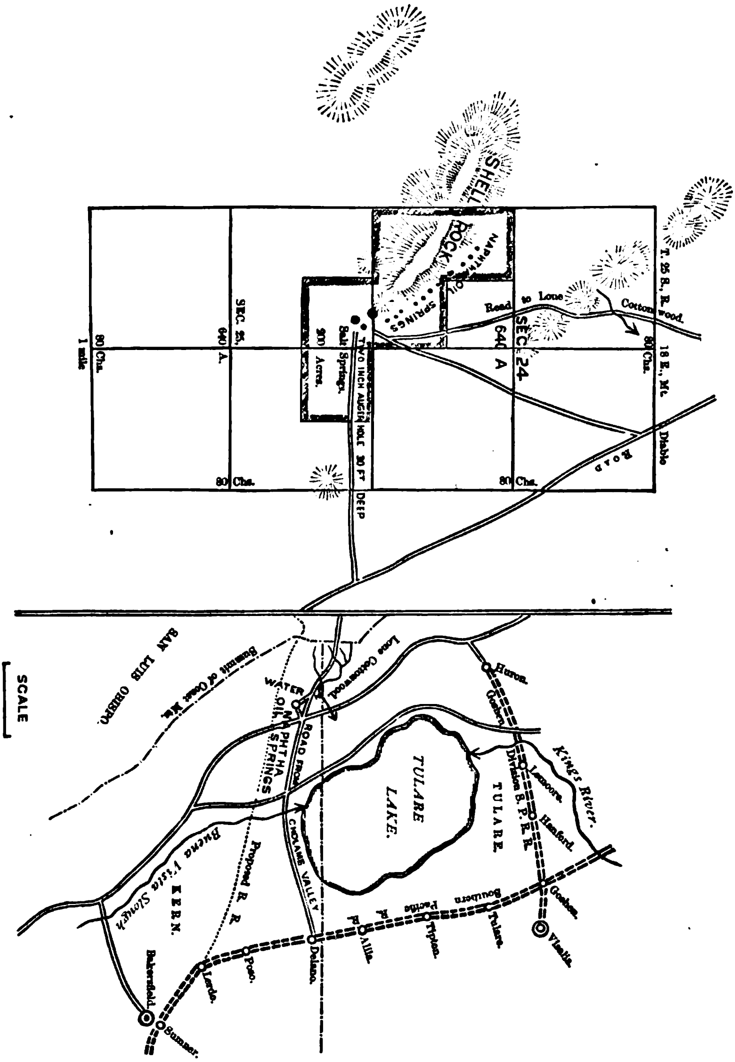
October nineteenth, visited a locality previously indicated by Mr. C. D. Gibbes, on Sections 24 and 25, T. 25 S., R. 18 E., M. D. M. Found here the salt spring, the chief tar spring, and the two-inch auger hole close together, also the string of little asphaltum spots called "naphtha springs," along the northeast side of the hill, and also the "shell rock," all approximately as laid down on the accompanying map. But the spots of asphaltum are none of them more than ten or twelve feet in diameter. There is no naphtha here, and the quantity of black viscid maltha is very small. There is none flowing. But in a few places (perhaps three or four), there is a very little of it to be seen in small holes, none of them over six inches in diameter. There is some sulphur as well as some mineral salts in the water from all the springs, and a *trace* of oil on top of some of them. The rocks here are not well exposed; but the "shell rock" strikes northwesterly and dips some 40° to the northeast. Barometer here at 10 A. M. read four hundred and thirty feet.

Another locality visited in Kern County is in the edge of the foothills of the Coast Range, west of Buena Vista Lake, and from twelve to fifteen miles northwest from the mouth of San Emidio Cañon. It is probably in T. 11 N., R. 24 W., S. B. M. By the wagon road, around the south side of Kern Lake, it is nearly a fifty-mile drive from Bakersfield.

At one place here an old stone chimney, ten or twelve feet high, still remains standing. Close by this chimney is a low knoll, on and about the summit of which there are several maltha springs, which have produced a patch of asphaltum covering the top and sides of the knoll, over an area of, perhaps, fifteen or twenty square rods—say one tenth to one eighth of an acre.

In the western part of this patch, near the foot of the knoll, somebody, years ago, had dug a trench or open cut, some twenty-five or thirty feet in length, and three or four feet wide, with a maximum depth of five or six feet, in the lowest portion of which a quantity (perhaps two or three barrels) of extremely thick and viscid black maltha had accumulated. The largest of the natural springs in this patch of asphaltum was exactly on top of the knoll, and though irregular in form, had a maximum length of some three feet, and a width of eighteen inches to two feet. The maltha in this spring also was black, and very thick and viscid.

Seeing that this little asphaltum patch was perfectly isolated, in a desert, where fire could not spread, I set fire to the spring on top of the knoll at 9 A. M., November first, not thinking it would burn over one or two hours. It burned furiously for awhile, sending up a huge column of dense black



smoke, through which the flame darted and leaped, at times twenty feet high or more. At the same time the fire gradually spread over the surface of the knoll till an area thirty feet in diameter was all aflame, and as there was a very light easterly breeze, the flame crept on towards the trench above mentioned, at the western foot of the knoll, which it at last reached. I stayed and watched the fire for about an hour, within which time it had begun to decidedly develop a peculiar mode of action, which will be described a little further on. From here we drove about five miles further west, within which distance we saw three other patches of asphaltum, all of them small, which we did not stop to examine much. I may as well explain here that we did not find the particular spot for which we were

hunting, because of the inadequate directions previously given by its owners to my guide, Mr. J. E. Chittenden, of Sumner. And as the day was waning, and we were in the desert, far from anywhere, it became imperative for us to seek some place to camp for the night, where we could find water and feed for the horses as well as something for ourselves to eat. So we came back by the road, passing the springs, etc., to which I had set fire, reaching there somewhere about 3 P. M. They were still burning, and we stopped half an hour or so more to watch them, inasmuch as their peculiar, spasmodic mode of burning was then well developed at every spring on the knoll, as well as in the trench at its western foot, where it was at that time most intense. Taking the spring on top of the knoll as an example, the way of it was this:

After burning furiously for awhile all over the surface of the spring, the flame died down. Meantime the flame had heated the pitch two or three inches deep below the surface, and set it boiling. As the boiling increased, the flame diminished, owing to steam being generated from the water beneath; which steam formed a large part of the bubbles issuing from the boiling mass, and gradually quenched the flame. The stuff would rise in the hole as a mere froth or scum, till it slightly overflowed, the flame meantime not entirely dying out, but continuing to burn with short flashes around the outer edges of the hole. After a few minutes the boiling would diminish, the overflowing cease, and the mass would gradually sink down three or four inches below the rim of the hole. A little later, the flame would begin once more to gradually creep over the whole surface, till another dense column of black smoke and flame arose. Then the fierce boiling would be recommenced, and the whole business repeated over and over again. How many times this took place I cannot guess. I only know that the next day (November second), when we were some ten or twelve miles away from there in an air line, considerable smoke was still arising at 10 A. M.

Los Angeles County.

PETROLIA.

The most southeasterly locality in this county (or indeed, so far as yet learned, in the State), where any considerable quantities of asphaltum can be seen, or where much boring has been done for oil, is the place called "Petrolia," which lies in a little valley on the southern side of the Puente range of hills, about ten miles northeast of the town of Anaheim, and some three or four miles southeast of the Puente Wells, which will be described hereafter.

Here, on the S.W. ¼ of Sec. 5, T. 3 S., R. 9 W., S. B. M., and close to where the line between Sections 5 and 8 intersects the eastern boundary of the Rancho San Juan Cajon de Santa Ana, a well has been sunk by Messrs. Hardison and Stewart, to a depth of eight hundred and fifty feet. Some samples of the drillings from this well, which were exhibited to me at Los Angeles, showed the following:

At three hundred and twenty feet.—Soft, and very fine-grained sandstone, with some gas, but no oil.

At four hundred and thirty feet.—Coarse sand. No gas nor oil.

At five hundred and thirty-five feet.—Very coarse sand, with some oil.

At five hundred and sixty feet.—Very fine sand.

At five hundred and seventy feet.—A somewhat clayey sand rock, containing grains as large as one eighth of an inch in diameter, with oil.

At six hundred and five feet.—Very fine sand, mixed with pebbles, some of them as large as one half inch in diameter.

This well has now been idle for some time. The oil is said to rise in it to within a few feet of the surface of the ground. But it has never been pumped; and it is the intention of the parties to sink it deeper. It is the most westerly of all the existing wells at Petrolia.

Very close to this well, two others were once sunk between one hundred and two hundred feet deep, both of them dry holes.

Within one hundred feet or so of the same well, still another one is said to have been drilled some years ago by Mr. B. Chandler, to a depth of four hundred or four hundred and fifty feet, when the casing caved in, and it was abandoned.

On the N.E. ¼ of Section 8, in the same township, Messrs. Mackey & Bentz drilled a well about three hundred and sixty feet deep, which is now idle; but from which there are said to have been shipped in the past somewhere between twenty and thirty carloads of about one hundred and thirty barrels each, of heavy oil, about 18° or 20° B.

On the N.W. ¼ of Section 9, Messrs. Chandler & Maxwell have sunk a well, which is now idle, but is three hundred and twenty-five feet deep, with an eleven-inch casing, and is to be sunk deeper as soon as they get heavier machinery. This well has not yet struck any notable quantity of oil.

About one hundred yards southeast of Chandler & Maxwell's well just noticed, they, last year, drilled a hole about three hundred and eighty feet deep, but got no oil, and only a very little gas. At this depth they struck something that turned the drill one side and made a crooked hole, so that they had to abandon it.

An old well, sunk by Mackey & Bentz, on the N.E. ¼ of Section 8, some nine hundred to one thousand feet northeasterly from their well above described, is about six hundred feet deep. This well they were obliged to abandon because their last string of casing in the bottom of the well was too small (being only three inches in diameter) to allow them to put another string inside of it in order to go deeper.

This makes eight wells in all that have been drilled at Petrolia, to depths ranging from one hundred to eight hundred and fifty feet, without, as yet, having yielded any profit; the two wells of Chandler & Maxwell on the N.W. ¼ of Section 9 being the most easterly ones of all.

These wells are scattered along a belt of tar springs and superficial asphaltum deposits, which stretches for more than a mile in a nearly east and west direction, but is quite narrow, being probably nowhere more than a hundred yards in width. The asphaltum is everywhere largely mixed with sand and pebbles. It is "refined" by melting it in large iron kettles, when the sand and pebbles sink to the bottom, and the clean asphaltum is ladled off the top of the kettle. It is shipped to Los Angeles, where it is used for coating iron pipes, and for other purposes. In places, the deposit is at least eight or ten feet thick, and the quantity available is very great.

This belt of asphaltum deposits, however, seems to terminate towards the east at about the locality of Chandler & Maxwell's wells. At one point, however, about a half mile farther east, there is said to be another small patch of it some thirty or forty feet long, and, perhaps, twenty feet wide, where a hole has been dug some four feet deep, out of which some five or six barrels of oil were taken in the course of one summer.

The exposures of the rocks here, along the asphaltum belt and in the immediate vicinity of the wells, are very few and poor. But, so far as can be seen, they seem to generally strike northeasterly, and dip northwesterly at varying angles. In some places they appear to lie nearly horizontal.

They consist of sandstones and conglomerates, the latter sometimes containing bowlders of granite and other rocks of considerable size. According to the aneroid, the altitude of this locality is about six hundred and forty-five feet.

Some half or three quarters of a mile northwesterly, and over the hill from Hardison & Stewart's well in Petrolia, lies the bed of "Bréa Cañon," which is the name given to the upper part of the main branch of Coyote Creek. It is needless to say that there are many "Bréa Cañons" and many "Coyote Creeks" in California. But this particular "Bréa Cañon" can be easily enough recognized from this description; and its general course in this immediate locality is about S. 60° W., magnetic. It is several hundred feet deep, and extends up almost entirely through the Puente Hills to the edge of the valley toward the east. The whole of it lies to the south and southeast of the Puente wells, hereafter described. So far as I could see and judge, the rocks in this vicinity, on the northwest side of Brea Cañon, seem to strike northeasterly and dip northwesterly. But on the southeast side of it they appear to dip towards the south. The exposures on this side, however, are very poor.

Going west from Hardison & Stewart's well at Petrolia, the belt of asphaltum deposits enters the Rancho San Juan Cajon de Santa Ana, and gradually ascends the southern slopes of the hills till at a point about a mile to the west, it crosses the crest, and then descends into Bréa Cañon, where there are again large bodies of it. The direction from Chandler & Maxwell's latest well to Hardison & Stewart's well is N. 74° W., magnetic, and the western prolongation of the Petrolia asphaltum belt follows nearly the same course. Yet the strike of the rocks, wherever seen in this ridge between Petrolia and Bréa Cañon, is generally from N. 50° E. to E., magnetic, and their dip, oftener than otherwise, to the north or northwest, though sometimes it is to the south or southeast. This state of things suggests a possibility of a series of faults having thrown the rocks in such a way as to arrange them "*en echelon.*"

At one locality on top of this range of hills, about a mile westerly from Hardison & Stewart's well, there is a large patch of superficial asphaltum with numerous small tar springs. Here a hole was dug some six or eight feet square and five or six feet deep, which has become partially filled with a viscid black maltha. A short time previous to my visit, a good sized sheep had fallen into this hole, and being unable to get out, had perished there; and the partly decomposed carcass, floating in and soaked with the tarry liquid, was a seething mass of fat maggots half an inch or so in length, many of which were also disporting themselves at their apparent ease in the surrounding maltha to distances of a foot or two away from the carcass. And I will here mention the fact that, so far as my observation extends, wherever tar springs occur in Southern California, it is usually easy, with a little search, to find spots where very small maggots are quite numerous in the liquid or semi-liquid petroleum. What they subsist on in many such cases, I do not know; nor do I know of any other living thing that can exist in this material. But the maggots certainly do live in it, and do not seem to be inconvenienced by it.

As well as could be judged from a partial exposure of the rocks near where this sheep lay, their strike at this point appears to be about N. 30° E., magnetic. But the dip is uncertain.

Going westerly from here, the course of the chief line of superficial asphaltum deposits, for a distance of a quarter of a mile or more, is S. 60° W., magnetic, though there are, here and there, some other patches which are not in this line.

At a point one eighth of a mile S. 75° E. from the dead sheep, where the belt of asphaltum deposits first reaches the top of the southern brow of the hills, the sandstones are somewhat exposed, and strike N. 75° to 80° W., and dip steeply to the northeast.

PUENTE.

From "Puente Station" on the Southern Pacific Railroad, some twenty miles east of Los Angeles, it is about five miles southeasterly to the oil wells of Messrs. Lacy & Rowland, situated on Puente Gulch, a branch of Coyote Creek. The locality of the wells is on the north side of the main crest of the Puente range of hills; but a little farther west, Puente Gulch turns south, breaks through that crest, and joins Coyote Creek. The wells are partly on the southeast corner of La Puente Rancho, and partly on Sections 34 and 35, T. 2 S., R. 10 W., S. B. M.

There are now (May 31, 1887) six pumping wells in operation here, all within a distance of some six hundred or eight hundred feet along the cañon, which here runs about west, magnetic. Of these wells, Nos. 1, 2, and 3 furnish a rather thick maltha, of about 20° B., and the others a lighter oil of 30° to 32° B. The first three wells are all pumped into the same tank, whence the oil is barreled and shipped to Los Angeles, where it is used for lubricating purposes, and for mixing with asphaltum for coating iron pipes, and for other purposes.

These three wells furnish some forty or fifty barrels per month, which is worth $5 per barrel. The lighter oil, from Nos. 4, 5, and 6, is worth $1 50 per barrel. It is all pumped and mixed together in the same storage tanks at the wells, and is again pumped from them into a tank on the top of the hill, one fourth of a mile or so to the north, and several hundred feet above the wells, whence it runs by its own gravity, through a two-inch pipe, a distance of about five miles, to a tank alongside the railroad, not far from Puente Station. It is thence discharged into tank-cars, in which it goes to Los Angeles.

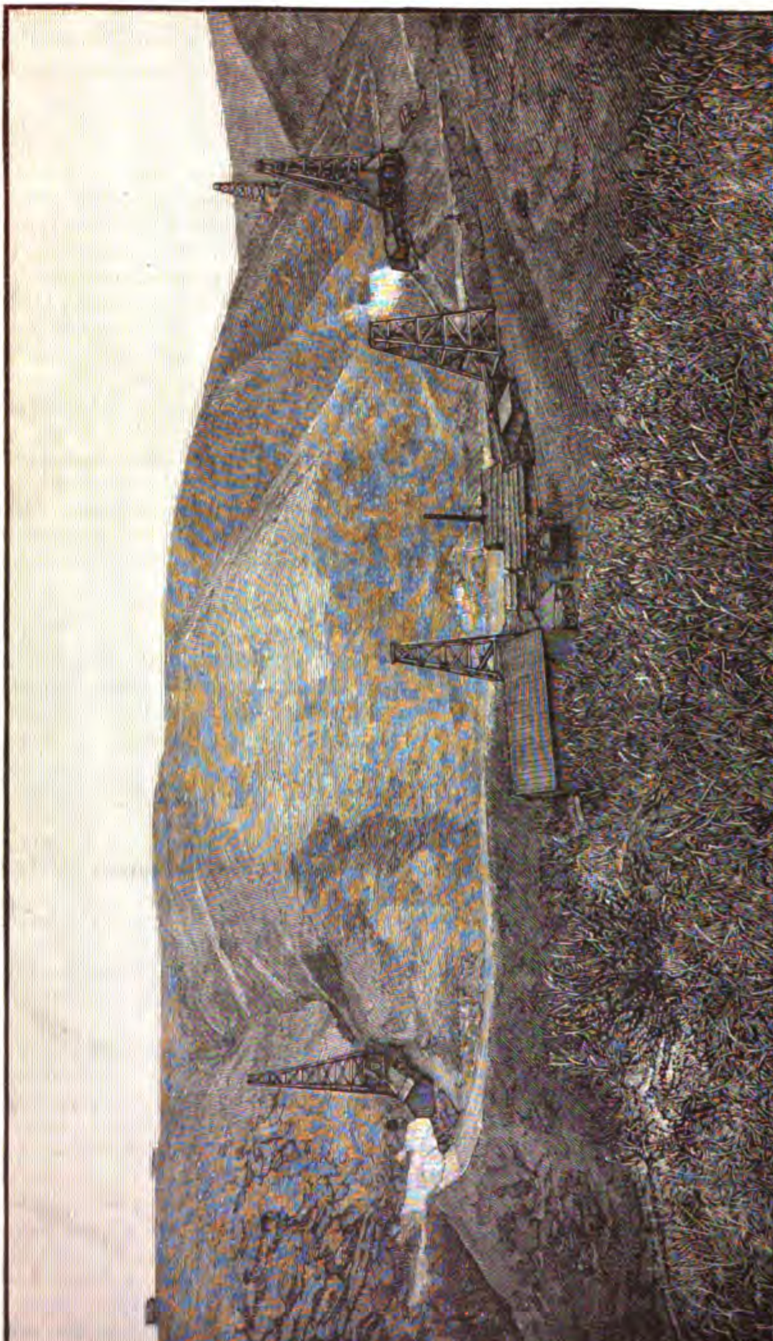
Wells Nos. 1, 2, and 3, are old wells, and are situated some twenty or thirty feet south of the bed of the gulch. The others are from thirty to two hundred feet north of it, on the hillside.

A streak of little croppings of bréa and maltha follows for nearly half a mile about an east and west course, just north of the bed of the cañon.

The largest tank at the wells has a capacity of something over five hundred barrels, and the smaller one in the same building holds one hundred and thirty barrels.

Nos. 1 and 2 were sunk previous to 1882, and are each one hundred and fifty feet deep. No. 3 began pumping in 1882, and is two hundred and sixty feet deep. No. 4 has a twelve-inch casing at top, is one thousand feet deep, and began pumping in January, 1886. No. 5 is eight hundred feet deep, and began pumping in July, 1886. No. 6 is eight hundred feet deep, and began pumping in January, 1887.

Since No. 6 was started the average aggregate production of all these wells has been about one hundred barrels per day, most of which comes from Nos. 4, 5, and 6, No. 4 being the most productive well. No. 7 is now drilling, with a thirteen-inch top casing, and is to-day (May thirty-first) down about one hundred and seventy-five feet. They say that they are making an average of about forty feet per day with it. This is the most westerly of all the wells here. Moreover, the grading is already done at the site of No. 8, which will soon be started, and will be the most easterly one of all.



PUENTE OIL WELLS, LOS ANGELES COUNTY, CALIFORNIA.

The rocks throughout this region are unaltered sandstones and shales, which often contain a good deal of lime. They generally strike about east and west, though in some places they are greatly disturbed and crumpled. On the south side of the cañon, where, however, the exposures are very few and poor, they seem generally to dip to the south, while on the north side, where the exposures are somewhat better, and where all the most productive wells are, they dip to the north at angles ranging from 60° to nearly horizontal, though the general average seems to be about 45°.

At a point in the bluff on the south side of the cañon, about opposite Well No. 7, the sandstone seems to strike about N. 65° E., and dip northwesterly about 25°. But, in the brow of another bluff of about the same height, some three hundred or four hundred feet farther west, they again strike about east and west, and dip 40° or 45° to the south.

As already stated, very few exposures of rock can be seen on the south side of the cañon. But it seems pretty certain that the general dip there is to the south, so that the cañon itself here occupies the place, either of a fault of considerable magnitude, or else of a sharp anticlinal fold in the rocks, the productive oil wells being on the north side of it where the dip is northerly.

The oil-bearing rock itself, in all these wells, is sandstone. There is no record of the strata passed through in the shallow wells, Nos. 1, 2, and 3. But in the deeper wells a layer of asphaltum, or bituminous rock, was passed through before reaching the oil-bearing rock.

The depths at which this asphaltum and the oil-bearing rock were struck in Wells Nos. 4, 5, and 6, respectively, were as follows:

	Asphaltum.	Oil Sand.
Well No. 4	100 feet	335 feet.
Well No. 5	180 feet	430 feet.
Well No. 6	230 feet	480 feet.

From the vertical depths here given, it is easy to compute the approximate actual thickness of the strata passed through, the average dip being about 45° to the north. None of the wells have passed entirely through the oil-bearing sandstone here, though Well No. 4 has penetrated to a vertical depth of six hundred and sixty-five feet into it.

Immediately overlying the oil-sand there are a number of thin layers of fine-grained, hard, and compact sandstone, while the oil-sand itself is somewhat coarser grained and softer. All the wells furnish some gas, but very little gas is found until the top of the oil-sand is reached. The total quantity of gas furnished by Wells Nos. 4, 5, and 6 is about the equivalent, as fuel, of five barrels of oil per day. In addition to this gas, they also consume under the boilers about two barrels of oil per day in making steam.

Mr. John Youle, Superintendent of these wells, thinks that four barrels, or about one thousand one hundred pounds, of this oil are about equal in value as fuel to one ton (two thousand pounds) of good coal. The gas ordinarily issues from the wells under very slight pressure, owing to the fact that its quantity is small and it is drawn directly from the wells to the furnaces. But Mr. Youle states that in Well No. 5, when it was once cased in tight and none allowed to escape for awhile, the pressure rose to at least one hundred pounds per square inch.

They estimate that the total cost of sinking and fitting up the three deepest wells, Nos. 4, 5, and 6, was about $30,000, an average of $10,000 each, or a general average of $11 54 per foot of depth for all three wells.

From the Puente wells the town of Anaheim bears S. 10° E., magnetic.

Mr. Youle estimates that the total yield of all the wells throughout the State for the years 1884, 1885, and 1886 was as follows: 1884, an average of 511½ barrels per day; 1885, an average of 564½ barrels per day; 1886, an average of 658 barrels per day.

The difficulty in burning petroleum under boilers with a blast of air only, is that, if sufficient air is not furnished, the combustion is very incomplete, and dense clouds of black smoke issue from the stack; while on the other hand, if sufficient air is furnished to insure complete combustion and produce no smoke, then the flame is very short, and the heat is concentrated under the front end of the boilers to such an extent as to rapidly burn out and destroy the iron. Instead, therefore, of a blast of air alone, a jet of steam is used, which atomizes the petroleum and delivers it into the furnace in the shape of an exceedingly fine spray, mixed with both air and steam, the further effect of the latter being to considerably retard the rapidity of combustion, thus producing a far longer, though smokeless flame, and preventing the excessive concentration of the heat under the front end of the boilers.

By this method, of course, a certain amount of heat is carried off by the steam and lost. But this loss is small in comparison with the great advantage gained, of a far better distribution of the heat and the preservation of the boilers, while at the same time effecting a complete combustion.

Considerable gas continues to escape from the petroleum for some time after it issues from the ground; and it appears that the gas thus evolved is capable, under some circumstances, of redepositing some liquid petroleum from it.

At various localities between Los Angeles and the Puente wells, a little asphaltum and an occasional small tar spring may be found; but nothing of any considerable extent or quantity.

In a cut on the road at the reservoir in East Los Angeles there is a sharp, beautiful, and perfect anticlinal fold, the strike being northeast and southwest, and the dip about 45° each way from the axis. But at a point less than two hundred yards northwest of this locality, the dip is unmistakably to the southeast, proving that there is also a synclinal fold somewhere between these two points.

At a number of other points in East Los Angeles, and also in the northern part of the city proper, the strata are seen to strike northeast, but with varying dips. In the vertical banks, over twenty feet high, exposed in grading for new buildings on New High Street, just back of the Post Office and the St. Elmo Hotel, the soft, yellow, fine sand and clay shales strike N. 50° E. and dip about 50° southeast. There is here considerable selenite in thin streaks parallel with the stratification, and in a few spots the shales are stained nearly black with carbonaceous matter; but there is no sign here of liquid oil or asphaltum.

Mr. McGinnis once sunk a well some three hundred feet deep on Boyle Heights, and another some five hundred or six hundred feet deep at Santa Monica, but struck nothing of any value.

At the Protestant Orphans' Home, in the northern part of the City of Los Angeles (called "Sonora Town"), a well was sunk, in which, at the depth of sixty feet, a considerable volume of gas was struck. The pipe was seven inches in diameter, and when the gas was lighted, it burned a solid flame six feet high for over an hour.

Another well, near Temple Street, was sunk by Mr. A. Polhemus, in 1865, to a depth of three hundred and ninety feet, through alternating layers of soft and hard sandstone. This well yielded water and some gas. The latter, when ignited, gave a flame, half an inch in diameter and several

feet long, which would burn all night. The dip of the sandstones here is to the southeast.

Near the Southern Pacific Railroad station, in the bed of the Los Angeles River, a well was drilled eighty feet deep, at the bottom of which they struck asphaltum, with some gas in sandstone.

Just back of the United States Hotel is another well, in which they passed through soft materials to the depth of about eight hundred and fifty feet, where they struck hard rock, and below that again soft shale, with salt water strongly impregnated with sulphuretted hydrogen and other gases.

In the outskirts of the City of Los Angeles, some three miles southwest of the City Hall, the crests of some low rolling hills are covered, over an area of several acres, with a deposit of asphăltum mixed with sand. At one place the bituminous strata are exposed for a distance of perhaps one hundred feet, in a bank some four or five feet high, and consist of fine-grained and extremely thin bedded, sandy shales, which strike about N. 70° E., and dip 60° to 65° southeast. The upturned edges of these shales are covered over with a deposit of recent soil and gravel, through which the maltha, which issues from the shales, slowly percolates upwards to the surface, where it gradually hardens into asphaltum. There are many little pools, most of them not more than one or two feet, but a few as much as five or six feet in diameter, of black and very viscid maltha, like very thick and sticky tar. Bubbles of gas, an inch or more in diameter, may occasionally be seen on the surface of this maltha.

At one point here a well was drilled by Mr. A. Polhemus, in 1865, to the depth of four hundred and forty feet, with three-inch casing. It went through fifteen feet of asphaltum and sand, and then through black shales to the bottom. It yielded salt water and a little oil. The tools are said to have been lost in the well. The latter is now full of maltha which, on May fifteenth, stood in the pipe (which rises about two and a half feet above the surface of the ground) at a level of about one and a half feet below the top of the pipe. But at times it rises and overflows the top of the pipe, and has formed around it quite a pool of maltha which is considerably more liquid than that of the other little pools which come from the little surface springs. To the north of this locality, for a distance of two miles or more, there are scattered small deposits of asphaltum and little springs of tar.

About four miles northwesterly from the Los Angeles Court House, a well was drilled some years ago by Ivan A. Weid, concerning which the following information was obtained: Struck surface water in gravel at twenty-eight feet. Went down about one hundred feet in soft formations. Put in eight-inch casing. Went through a slate formation, requiring no casing, five hundred and fifty feet. At three hundred and fifty feet struck a streak of oil and bréa in a sandstone formation. At five hundred and seventy-five feet casing became necessary. The sandstone continued to six hundred and fifty feet. From six hundred and fifty to eight hundred and twenty feet in slate, with streaks of soft sandstone and bréa, the last thirty feet, from seven hundred and ninety to eight hundred and twenty feet, being in very soft sand rock requiring casing. At four hundred and fifty feet water commenced flowing from top of well with gas and oil. There were several streaks of soft sand at intervals with indications of oil; but no sufficient quantity of oil to be of any value.

At La Bréa Rancho, described in the Fourth Annual Report of the State Mineralogist, page 287, the strata are but very little exposed anywhere, the ranch lying in the nearly level valley, several miles from the foot of the

hills in any direction. From what little could be seen at one or two points, however, they seem to lie nearly horizontal, and to consist of soft sandstones and shales, with some gravel; the pebbles being sometimes an inch or so in diameter, and all, more or less, impregnated with bitumen.

Considerable gas escapes here from the excavations which have been made in digging out the asphaltum, and also from some of the tar springs which are scattered over the asphaltum deposit.

A deep well has also been drilled here for oil without success, by Messrs. Stewart & McFarland. Samples seen at Los Angeles, and said to have come from this well, were as follows:

At eighty-one feet—Coarse gray sand.
At eighty-three feet—Very fine-grained, black, bituminous shale.
At four hundred and twenty feet—Coarse-grained, pebbly sand, yellowish-brown in color.
At four hundred and seventy-nine feet—Dark brown bituminous shale.
At six hundred and fifty-one feet and at six hundred and fifty-eight feet—Black, sticky, bituminous shale.

But Mr. McGinnis, who drilled this well for Messrs. Stewart & McFarland, gives from memory the following statement of the strata through which he passed, beginning at the surface:

Fifty-three feet—Black sand and bréa.
Forty-five feet—Quicksand.
Eighteen feet—Hard shale.
Two hundred and forty-eight feet—Black sand and bréa.
Eighteen feet—Hard shale.
Six hundred and eighteen feet—Sand and bréa.
Three hundred and twenty feet—Soft, blue mud.
Thirty feet—Oil-sand.
One hundred and thirty-five feet—Soft, blue mud.

Making the total depth of the well one thousand four hundred and eighty-five feet. At nine hundred and eighty-eight feet struck water, and at one thousand feet the well began to flow salt water from the top. There was also considerable gas here, but no valuable quantity of oil.

To the south of here, and between the Rancho La Bréa and the hills lying south of the Rancho La Cienega, a number of other wells have been sunk to depths ranging from eighty to two hundred feet, and in which, at various depths, sulphur water and gas were found, but no oil of any value.

About ten miles, a little north of west from the City of Los Angeles, on the northern part of the Rancho Rodeo de las Aguas, and just at the foot of the Santa Monica Range of mountains, there are some tar springs and patches of asphaltum, and Mr. A. H. Denker has drilled a well here to the depth of five hundred and twenty feet through the following strata:

90 feet—Soft and loose materials.
100 feet—Slate and quartz sand rock.
100 feet—Black sand rock.
10 feet—Slate.
100 feet—Sandstone, with a little oil.
65 feet—Sandstone, with tar and sulphur water.
15 feet—Very fine and hard sand.
15 feet—Sand, with a little oil.
25 feet—Black slate, with pyrites.
—
520

The first water in this well was struck at twenty-five feet. At four hundred and sixty-five feet strong sulphur water containing some gas was found. The mouth of this well is about five hundred feet above the sea. The course from here to the well at La Bréa Ranch is S. 68° E., magnetic—

distance, about four and one half miles—while the Puente wells, near thirty miles distant, bear S. 85° E.

There are no good exposures of the rocks in this vicinity. In the gulch, close by the well, the surface rock is seen to be a micaceous clay slate, dark colored and soft, but its strike and dip could not be determined.

At a locality visited on the Buenos Ayres Ranch, some two and one half or three miles west of Denker's well, and at about the same height above the sea, there is an exposure of heavy-bedded sandstones with streaks of soft clay shales intercalated. These sandstones are soft and unaltered, and strike about N. 60° E. and dip 12° to 15° to the southeast.

At the time of my visit to Denker's well there was trouble with the casing, which they were trying to draw out. But I was afterwards informed that they did not succeed in getting it out, and so abandoned the hole and started a new one.

The present variation of the magnetic needle at Los Angeles, as given by Mr. Hadler, the United States magnetic observer there, is 14° 29′ E.

About eleven miles south of Los Angeles, in what is known as the "Rosecranz Tract," and on the S.E. ¼ of Section 18, T. 3 S., R. 13 W., S. B. M., Mr. Milton Thomas has a well drilled one hundred and thirty-five feet deep, in which at the depth of eighty-five feet quite a strong flow of gas was struck. The well was drilled by Mr. Putney, who states that when the gas was first lighted at the mouth of the seven-inch pipe it burned right straight along, a solid flame not less than ten feet high.

Mr. Thomas now has it cased in, and is using the gas for all domestic purposes in his house. I should judge the well would furnish now one thousand cubic feet or more of gas per hour under a pressure of perhaps half a pound to one pound per square inch.

Along the seabeach, from near the town of San Pedro to Point Firmin, and it is said for some eight or ten miles west of there, the bituminous shales and sandstones are exposed in cliffs fifty to one hundred feet or more in height. So far as seen, they are all sandstones, varying, however, from a very fine-grained, dark bluish, soft rock, whose whole mass is impregnated with bitumen, to a coarse-grained, light yellow sandstone, in which the bitumen appears only in spots and seams. These rocks are more or less disturbed and bent, and sometimes faulted. Their strike ranges from N. 30° W. to N. 60° W., and their dip from 10° to 30° to the northeast. I did not learn of any deep wells having been drilled in this vicinity.

PICO CAÑON.

At the present time, the most productive petroleum locality in Los Angeles County is at Pico Cañon, of which some description is given in the Fourth Annual Report of the State Mineralogist. The wells are situated in and about the head branches of Pico Cañon, which runs northerly out of the San Fernando Range of mountains to the Santa Clara Valley. In all, something over thirty wells have been drilled here to various depths, ranging from five hundred to two thousand three hundred and thirty feet. The product is a green oil whose gravity is from 40° to 42° B. There is here a storage tank of twenty thousand barrels capacity. The oil from the different wells is all mixed together and piped from here to Newhall, whence most of it goes by rail to the refinery at Alameda. There is only one flowing well; all the rest are pumping wells, though some of them would flow more or less if they were not pumped.

As to the flowing well, the experiment of pumping it has also been tried, but this did not increase its production sufficiently to justify the expense.

WELLS AT PICO CAÑON.

All the wells produce also some gas, the whole of which is utilized under the boilers, except in the case of two wells, where there is a surplus, which escapes from two iron pipes into the open air and burns with constant flames from two to four feet long.

Nearly all the oil is found in a light-gray, porous sandstone, and the deepest wells have none of them reached the bottom of this sandstone. The coarsest grains in the drillings from this rock range from one thirty-second to one sixteenth of an inch in diameter.

The rocks here have been greatly plicated, crushed, and broken, and there is either a sharp anticlinal fold, or else a large fault of unknown magnitude, running for some distance nearly east and west, on the north side of which the rocks dip to the north with an average pitch of about 70°, and on the south side of which they dip to the south at steep but varying angles. To the south of this "line of break," as it is called, no productive well has ever yet been found, though five or six holes have been drilled there, one of them to a depth of fifteen hundred feet.

In the western part of this field there is another disturbance, and the rocks there dip between W. and S.W., at angles of from 30° to 45°. There are one or two productive wells here in these southwesterly dipping rocks.

Within the productive belt here, it is not true, as a general rule, that the best wells are either on the south or north edge of the belt. Nor is it true that the best wells are either the deepest or the shallowest.

The rocks exposed at the surface here consist of an exceedingly complex series, so far as their physical characteristics are concerned. They range from the very finest and thinnest-bedded clay shales, up through various grades of sandstones and fine gravel rocks to very coarse conglomerates. But Mr. Craig states that, within the most productive area here, they have as a general rule, struck any given stratum at about the depth at which they might have expected to strike it, taking the surface strike and dip as a guide; thus showing that *within this small area* the rocks are not greatly faulted.

They pump here steadily day and night, and Sundays also, and run their pumps more rapidly than they do at Puente; though the speed of the pumps varies somewhat at the different wells.

The general rule is that each well is more productive for a short time after it is first drilled than it is afterwards. But Mr. Craig states that these wells are more permanent than the Pennsylvania wells, and though their daily product is comparatively small, yet he thinks their ultimate gross production will, before final exhaustion, prove to be greater than the average of the wells in Pennsylvania.

The following description of these wells was furnished by Mr. Craig:

The well furthest up the main branch of the cañon, *i. e.*, furthest to the south, is known as "Pico, No. 11." It is in the bed of the cañon, about two hundred or two hundred and fifty feet south of the "break," is fifteen hundred feet deep, and developed nothing except some water, a little tar, and a little gas. The water has a slightly bituminous taste, but does not seem to contain any noticeable quantity of mineral salts.

"Pico, No. 10" is in the bed of the cañon, one hundred or one hundred and fifty feet south of the "break." It was sunk nine hundred feet deep, when the tools were lost in it, and it was abandoned. A very little oil flows from it, but not enough to be of any value.

"Pico, No. 2" comes next below No. 10, in the bed of the cañon. It is about nine hundred feet deep, and pumps about five barrels per day of oil of about 40° B. This well is right *in* the "break," and the oil was struck at about seventy-five feet depth. It was drilled in 1875.

"Pico, No. 1" is next in order down the cañon, is right in the "break;" is seven hundred feet deep, and also pumps about five barrels per day. In this well also, the oil was struck at a depth of about seventy-five feet.

"Pico, No. 4" comes next below No. 1 in the cañon. It was sunk in 1876 to the depth of about one thousand feet. It is probably one hundred feet north of the "break," and is pumping about thirty barrels per day. It at first yielded about seventy-five barrels per day, being then only six hundred feet deep. But it gradually fell off till it gave only fourteen barrels per day, when they drilled it deeper.

"Pico, No. 5" is the next well below No. 4, in the bed of the cañon. It is some three hundred feet north of the "break;" is one thousand one hundred feet deep, and pumps about twenty-five barrels per day.

"Pico, No. 9" is in the bed of the cañon below No. 5. It is nearly five hundred feet north of the "break;" is one thousand five hundred and fifty feet deep, and pumps about thirty-five barrels per day.

The foregoing are all the wells situated in the bottom of the main cañon.

Going westerly up the branch cañon from "Pico, No. 1," we find successively "Pico, No. 8," "Pico, No. 12," and "Pico, No. 13."

"Pico, No. 8" has three different holes close together—one five hundred feet deep, one one thousand feet deep, and the other one thousand five hundred feet deep. This is on the south side of the "break," and probably one hundred and fifty or two hundred feet from it. The one thousand feet hole produced for awhile some five or six barrels per day; but is now practically dry. The other two holes were both dry.

The other two wells, "Pico, No. 12," and "Pico, No. 13," are both of them north of the "break."

"Pico, No. 12" is one thousand three hundred feet deep, and pumps about eighteen barrels per day.

"Pico, No. 13" is one thousand six hundred feet deep, and pumps forty barrels per day.

The last two wells both produce a rather heavy oil, said to contain more

paraffine than that from any of the other wells. They also produce a larger quantity of gas than any of the other wells, only a portion of which is required to make steam for pumping them, the balance being allowed to escape and burn in the open air.

"Pico, No. 14" is still farther west. It is one thousand five hundred feet deep, but is a dry hole. It is probably south of the "break," the course of which at this locality seems to be about N. 75° W.

About one thousand or one thousand two hundred feet west of "Pico, No. 14," there is another dry hole called "Simi, No. 1," which is one thousand three hundred feet deep.

"Pico, No. 6" is on the hillside, about four hundred feet due west from "Pico, No. 4," and about one hundred feet above it. It is one thousand five hundred feet deep, and pumps about twenty-five barrels per day.

"Pico, No. 7" is on the hillside some three hundred feet east of No. 4, and some fifty feet higher. It is one thousand two hundred feet deep, is a *flowing* well, and yields about forty barrels per day.

About four hundred feet, a little north of west from "Pico, No. 5," and one hundred and fifty feet above it, is the "H. & S. Star" well "No. 1," which is one thousand six hundred and fifty feet deep, and pumps about thirty barrels per day.

About six hundred feet east of "Pico, No. 2," and two hundred and seventy-five feet above it, is "San Fernando, No. 1," which is one thousand two hundred feet deep, and pumps twenty barrels per day.

Three hundred and fifty feet further east, and still fifty feet higher, is "San Fernando, No. 2," which is one thousand four hundred and fifty feet deep, and pumps forty barrels per day.

About five hundred feet, a little east of north from "San Fernando, No. 1," and two hundred feet lower, is "San Fernando, No. 4," which is one thousand five hundred and fifty-five feet deep, and pumps about eighteen barrels per day.

Some five hundred feet east of the last well, and fifty feet higher, is "San Fernando, No. 5," which is one thousand six hundred feet deep, and pumps fifteen barrels per day.

About six hundred feet east of "San Fernando, No. 2," and some forty or fifty feet lower, is "San Fernando, No. 3," which is one thousand three hundred and seventy-five feet deep, and pumps twenty-five barrels per day.

Five hundred feet northeast from "San Fernando, No. 5," and seventy-five to one hundred feet lower, is "San Fernando, No. 7," which is one thousand nine hundred feet deep, and is a dry hole.

About three hundred feet northwest of "San Fernando, No. 1," and one hundred feet lower, is "San Fernando, No. 8," which is one thousand three hundred and twenty-five feet deep, and pumps sixty barrels per day.

About four hundred feet northeast of "San Fernando, No. 3," and about one hundred feet lower, is "San Fernando, No. 6," which is two thousand three hundred and thirty feet deep, and pumps ten barrels per day.

Three hundred feet a little north of east from "San Fernando, No. 3," and nearly at the same height, is "San Francisco, No. 4," which is one thousand five hundred and fifty feet deep, and pumps forty barrels per day.

About five hundred and fifty feet south of "San Francisco, No. 4," and some seventy-five feet lower, is "San Francisco, No. 2," which is fifteen hundred feet deep, and pumps five barrels per day.

About six hundred feet northeast of "San Fernando, No. 6," and about

one hundred feet lower, is "San Francisco, No. 3," which is thirteen hundred feet deep, and is a dry hole.

About four hundred feet northeast of "San Francisco, No. 2," and some fifty feet lower, is "H. & S. Hill, No. 3," which is one thousand six hundred feet deep, and pumps five barrels per day.

About eight hundred feet a little north of east from the last preceding well, and two hundred and fifty feet higher, is "H. & S. Hill, No. 1," which is eighteen hundred feet deep, and is a dry hole.

About five hundred feet southeast of "H. & S. Hill, No. 1," and some fifty feet higher, is "H. & S. Hill, No. 2," which is one thousand two hundred feet deep, and is a dry hole.

This shows a total of thirty-three wells (counting the three holes at "Pico, No. 8," separately), of which two are unaccounted for, eleven are dry holes, and twenty are productive wells, yielding an aggregate of four hundred and seventy-one barrels per day.

The dry holes range from five hundred to one thousand nine hundred feet in depth, and their aggregate length is fourteen thousand four hundred feet.

The productive wells range from seven hundred to two thousand three hundred and thirty feet deep, and their aggregate length is twenty-seven thousand nine hundred and eighty-five feet.

All the productive wells are contained within an area three thousand eight hundred feet long, east and west, by one thousand two hundred feet wide, north and south, and bounded on the south by the line of the "break." To the south of this line the exposures are so few and poor that it is impossible to say with certainty whether the "break" is really a great fault, or only a sharp anticlinal fold of the rocks. So far as can be judged from appearances, however, it seems most probable that it is a fault.

Both east and west of the productive area the rocks are irregularly and greatly disturbed.

The pump rods work in two-inch tubing, which generally runs down to within about one hundred feet of the bottom of the well. The casing usually extends only part way down the well, as the sand rock in which the oil is found is hard enough to stand alone.

The quantity of water encountered in drilling these wells was not large.

The oil pipe to Newhall is two inches in diameter and seven and one fourth miles long.

In June, 1886, a torpedo of thirty pounds of Hercules powder was exploded at a depth of nine hundred feet in "Pico, No. 4," but produced no effect whatever upon its yield. "Pico, No. 1" was sunk in 1875; No. 2 in 1875; No. 3 in ——; No. 4 in 1876; No. 5 in 1880; No. 6 in 1880; No. 7 in 1882; No. 8 in 1882; No. 9 in 1882; No. 10 in 1882; No. 11 in 1882; No. 12 in 1882–1883; No. 13 in 1882–1883; No. 14 in 1883. "Simi, No. 1," was sunk in 1883–1884. "H. and S. Star, No. 1" was sunk in 1883. "San Fernando, No. 1" was sunk in 1882; No. 2 in 1882; No. 3 in 1882; No. 4 in 1882; No. 5 in 1882; No. 6 in 1882; No. 7 in 1882; No. 8 in 1886–1887. "H. and S. Hill, No. 1" was sunk in 1883; No. 2 in 1883; No. 3 in 1883. "San Francisco, No. 2" was sunk in 1881; No. 3 in 1883; No. 4 in 1883.

The first five hundred or six hundred feet, in nearly all the wells, consist of alternating beds of sandstones and shales; but below about this depth, only solid sandstone is met with. The shales are often very thin-bedded and fragile, and casing is required down through them into the sandstone. In "Pico, No. 9," however, they had soft shales as deep as nine hundred feet.

The altitude of these wells above the sea ranges from eighteen hundred

to about two thousand three hundred feet. The altitude of Newhall Station is about one thousand two hundred and fifty to one thousand three hundred feet.

Most of the above information concerning these wells was kindly furnished by Mr. M. R. Craig, the General Superintendent and Manager.

The tank at Newhall holds two thousand barrels. The following is a tabular recapitulation of some of the most important data concerning the Pico Cañon wells:

Name of Well.	Date when Drilled.	Depth in Feet.	Product in Barrels per day in July, 1887.
Pico, No. 1	1875	700	5
Pico, No. 2	1875	900	5
Pico, No. 3	------	------	------
Pico, No. 4	1876	1,000	30
Pico, No. 5	1880	1,100	25
Pico, No. 6	1880	1,500	25
Pico, No. 7—*flowing*	1882	1,200	40
Pico, No. 8	1882	500 1,000 1,500	0
Pico, No. 9	1882	1,550	35
Pico, No. 10	1882	900	0
Pico, No. 11	1882	1,500	0
Pico, No. 12	1882–1883	1,300	18
Pico, No. 13	1882–1883	1,600	40
Pico, No. 14	1883	1,500	0
Simi, No. 1	1883–1884	1,300	0
H. and S. Star, No. 1	1883	1,650	30
San Fernando, No. 1	1882	1,200	20
San Fernando, No. 2	1882	1,450	40
San Fernando, No. 3	1882	1,375	25
San Fernando, No. 4	1882	1,555	18
San Fernando, No. 5	1882	1,600	15
San Fernando, No. 6	1882	2,330	10
San Fernando, No. 7	1882	1,900	0
San Fernando, No. 8	1886–1887	1,325	60
San Francisco, No. 1	------	------	------
San Francisco, No. 2	1881	1,500	5
San Francisco, No. 3	1883	1,300	0
San Francisco, No. 4	1883	1,550	40
H. and S. Hill, No. 1	1883	1,800	0
H. and S. Hill, No. 2	1883	1,200	0
H. and S. Hill, No. 3	1883	1,600	5

In Little More Cañon, about two miles east of Pico Cañon, two wells were sunk by Messrs. Hardison & Stewart in 1882 and 1883. These wells are, according to Mr. Craig, about half a mile north of the apparent course of the "break" in the rocks in Pico Cañon. No. 1 is about one thousand feet deep, and in it they found a small quantity of heavy black maltha, which looks like that from the Puente wells. A very small stream of it is now trickling out from the mouth of the well; but there was not enough of it to be of any value.

No. 2 is a short distance farther down the cañon, is only about seven hundred feet deep, and is a perfectly dry hole.

Wiley Cañon is about three miles east of Pico Cañon. Here there seems to be a similar fault or "break" in the rocks to that in Pico Cañon. But in Wiley Cañon there is a much greater quantity of extremely thin-bedded shales, and the local disturbances seem to be much greater. There are some very queer contortions of these shales here.

From what appears to be the line of "break" in this cañon, there have been two tunnels driven southerly, one of them three hundred or four

hundred feet in length. These tunnels struck some water and a little oil; but not enough of the latter to pay for saving it. A very small quantity of tarry oil is constantly flowing from them now.

Two wells have also been sunk here, one about nine hundred feet deep, and the other one thousand three hundred and twenty-five feet deep. Neither of these wells gave oil in paying quantities, though both of them gave a little rather heavy oil, about 36° B., of a dark green color.

At the nine hundred feet well, which is just on the south edge of the "break," the water and oil stand in the pipe at the surface of the ground, and there is a very small overflow from it. There is also some gas bubbling up from it.

At the one thousand three hundred and twenty-five feet well, which is just on the north edge of the "break," the water and oil stand some ten or fifteen feet below the surface of the ground, and there is a small seepage from it into the immediately adjacent cañon. Here also there is some gas.

The water from both these wells is impregnated with various mineral salts, and that from the one thousand three hundred and twenty-five feet well has formed small stalactites on the hillside.

A short distance below these wells, in the cañon, there is a sulphur spring, whose waters are also impregnated with various alkaline salts.

Some of the local foldings of the rocks, more especially of the thinner shales, in Wiley Cañon, even within such short distances as ten to fifteen feet, are extremely complex.

The surface indications of either oil or asphaltum in all these cañons are very small; especially so in Pico Cañon, where extremely little of it can now be seen, whatever may have been the case previous to the sinking of so many wells.

It is stated in the Fourth Annual Report of the State Mineralogist, p. 294, that oil oozes from the ground in Casteca Cañon, a branch of the Santa Clara River coming in from the north, and nearly opposite to Pico and Wiley Cañons on the south. But I could not learn that any drilling had ever been done there, and, therefore, did not spend time to visit the locality.

There is also said to be some asphaltum in a cañon called "Dapple Cañon," some two and a half or three miles northeast of Camulos, and close to the boundary line between Los Angeles and Ventura Counties.

Furthermore, there is said to be asphaltum with some seepages of petroleum in the mountains some six or eight miles southeast of Newhall, but this locality was not visited for want of time.

Monterey County.

The deposit of bituminous sandstone owned by Mr. Godfrey was visited on September ninth. It is on the S.W. ¼ of Section 35, T. 24 S., R. 10 E., M. D. M., on the right bank of San Antonio Creek, west of Bradley's Station, in Monterey County. No developments have been made yet at this locality. But there is a belt of bituminous sandstone visible, some twenty or twenty-five feet thick, which strikes about N. 15° W., magnetic, and dips about 70° to the east. So far as can be seen, the rock does not seem to be generally very rich in bitumen. The sandstone alternates with grits and conglomerates. In the hill, about a quarter of a mile northwest of here, on the opposite side of the creek, the sandstones and shales strike about N. 65° W., and dip 50° or 60° N.E.

There are no springs of liquid petroleum, nor pitch, to be seen here. This locality is close to, and the bituminous rock crosses, the old stage road

from San Luis Obispo, *i. e.*, the old "Coast Line" road. Some two hundred yards, about N. 50° W. from the first outcrop mentioned, and on the opposite side of the creek, the bituminous sandstone shows again in the bank of the creek. At a point N. 60° W. from the first locality, the same heavy body shows again in the bluff one hundred and fifty or two hundred feet above the creek. Overlying the mass above mentioned at the first locality, there is first forty or fifty feet of barren sandstone, and then a bed of richer material some twenty feet or so in thickness. The pebbles in the conglomerate, which is interstratified with the sandstones, are chiefly quartz, flint, granite, and occasionally volcanic rocks, much water-worn and smoothly rounded. In the sandstone there are many angular fragments of white clay rock and flinty shale, of which very heavy bodies underlie the sandstones. Underlying this heavy body of bituminous rock in the shales on the opposite side of the creek, there is to be seen in one place in the bluff another streak of bituminous sandstone from two to five feet thick, between which and the first mass described, there is a thickness of one hundred and fifty or two hundred feet of barren shales. About a quarter of a mile farther up the creek there is a cold sulphur spring, somewhat alkaline. There are also beds of the clayey and flinty shales overlying the first heavy mass of bituminous rock. There is said to be also an outcrop of the bituminous sandstone about two miles a little east of south from here, on the Nacimiento Creek, where it lies nearly horizontal.

One quarter of a mile below here, and thence all the way to the Salinas River, a distance of some five miles, the more recent rocks lie nearly horizontal. No shells have been found here. But on the Nacimiento there are said to be several beds which are full of them. The heavy deposit of bituminous sandstone on San Antonio Creek can be traced for about a quarter of a mile southerly up the hill, when it disappears under surface materials till it reappears on the Nacimiento.

At Bradley's station the Salinas River runs just about west, magnetic; and on the north side of the valley the rocks seem to dip northerly at not very high angles.

On a little creek, two or three miles about S. 80° W. from San Ardo station, there is considerable asphaltum and some little ooze of pitch for a distance of about two hundred and fifty or three hundred feet along the creek. The sandstone here strikes about N. 68° W., and dips about 65° to the northeast, and is overlaid by a bed of soft recent breccia, in which the stones are almost exclusively sharply angular fragments of nearly white clay rock, the deposit varying in thickness from four to ten feet or more. Immediately on the southeast side of the creek is a rather heavy outcrop of bituminous sandstones, which furnish the seepages in the creek.

The rocks whose strike and dip are given above overlie the bituminous sandstones. The latter strike N. 50° to 60° W., and dip 65°, or so, to the northeast. The whole belt of them is probably one hundred feet or so in thickness; but they seem to be in three or four different beds, which, perhaps, have barren beds between them. The rock exposed on the surface is nearly all of it rather poor in bitumen, its color being brown. But it must be richer in depth to have furnished the seepages in the creek. Barometer here read six hundred and twenty feet. Barometer at San Ardo read five hundred feet. It is reported that somewhere about three or four miles southeast of here there is another deposit of similar material in the hills southwest of San Ardo. Just above the bituminous sand rock, above described, there is in the gulch a cold, white sulphur spring.

Not far from Godfrey's, but on the south side of San Antonio Creek, there is said to be more bituminous sand rock. Mr. Chas. Romie used to own the

land where the bituminous outcrops occur west of the town of Soledad, in Vaquero Cañon, a branch of Release Cañon, which is a branch of Arroyo Seco, which latter comes into the Salinas River from the west, about one mile above the town of Soledad. He states that there is a small quantity of asphaltum to be seen on the surface of the ground here, but not much, and that there is one small hole dug here in which there is some petroleum to be seen, but not much. The distance from Soledad is some twelve to fifteen miles. Mr. Romie also says that the rocks there are much crushed and broken up, and that there are sulphur springs near by. All the white sulphur springs in this region seem to contain more or less alkali.

The bluffs on either side of the Salinas River, for many miles northwest from Bradley's to near Salinas, are from twenty to fifty or more feet high, and look as if their accumulation had been due to causes perfectly similar to those now at work in the bed of the Salinas River, as they seem to consist of masses of wind-drifted sand, irregularly stratified, and alternating with deposits made by shifting currents of running water.

The pavement in front of the railroad station at Castroville is of bituminous sand rock from near Santa Cruz. It has now been down some seven or eight months, and is in perfect condition.

CHOLAME VALLEY.

During the past few months there has been some little excitement in the newspapers and elsewhere about reputed discoveries of petroleum in the Little Cholame Valley. This locality was visited on the nineteenth of October.

Cholame Creek flows southeasterly for a number of miles through a valley of the same name in the southeastern corner of Monterey County, in the mountains between the Salinas River and the Tulare Valley.

"Cholame Store," at the lower end of the main valley, is in San Luis Obispo County, but all the upper part of the valley is in Monterey County.

The barometer at Cholame Store read eleven hundred feet. About six miles below, *i. e.*, southwesterly from here, the main Cholame Creek joins La Estrella Creek, which then flows to the Salinas River. From "Cholame Store," it is about fifteen miles up the valley in a northwesterly direction to the junction of the "Main" and "Little" Cholame Creeks. The former comes in at the junction from a westerly direction, while the latter comes in from the northwest. The town of Parkfield is in the Little Cholame Valley, less than a quarter of a mile above its junction with the Main Cholame. It is on Sec. 26, T. 23 S., R. 14 E., M. D. M. Barometer here read one thousand three hundred and thirty feet. In the valley here, there are several square miles of nearly level fertile land, rather heavily timbered with scattering old oaks, which this year are loaded with acorns, and which probably gave the name of "Parkfield" to the town.

I was not able to obtain any definite information concerning any deposits of asphaltum or petroleum in the Main Cholame Valley, except the statement that if such exist they are few and small. But in and about the Little Cholame there are several localities where they occur.

About one and a half miles northerly from Parkfield, in Joaquin Cañon, along the southern foot of Table Mountain, there is some surface asphaltum, and a number of small springs of black maltha. The lower part of the mountain here is a heavy mass of serpentine; while the upper portion is unaltered and very heavy-bedded sandstone, which probably dips northeasterly. The petroleum seems to issue from these sandstones and then to seep for some distance down the mountain side through the loose debris over-

lying the serpentine before it finally appears at the surface. Along with the maltha there is more or less sulphur water and a very little gas. At one sulphur spring there is a barrel set about on a level with the line of maltha springs, where the barometer read one thousand nine hundred feet. This is on Sec. 13, T. 23 S., R. 14 E., M. D. M. So far as could be learned, it appears that this body of serpentine is a completely isolated one, and not more than a quarter of a mile in diameter in any direction.

Mr. John Fisher lives in the Little Cholame Valley, about five miles above Parkfield, and he states that for a distance of one or two miles along the low hills on the southwest side of the valley, near his house, there are small seepages of maltha in almost every gulch. But there are none in this vicinity among the hills on the northeast side of the valley. Some two or two and a half miles above Fisher's house, there is a little gulch coming into the valley from a direction of S. 20° W., magnetic. This locality is on the southeast quarter of Sec. 31, T. 22 S., R. 14 E., M. D. M. A short distance up this gulch there is a somewhat extensive though isolated mass of granite exposed in place, some of which is much decomposed and soft, while other portions of it are yet quite hard. And at one point in the bed of the gulch, there is a little seepage of tar, which issues directly out of the granite itself, into the seams of which it has undoubtedly found its way from some of the near adjacent rocks. The surface wash about here is heavy and deep, and the rocks are but little exposed. But at one point a few hundred feet above the maltha seepage, in the southeastern branch of the gulch, there is a very small exposure of soft clay shales which seem to dip northerly—*i. e.*, towards the granite—but are evidently much disturbed. Their angle of dip, where visible, is some 12° or 15°. In this same gulch, about fifty feet above, *i. e.*, southerly from the maltha seepage, there were noticed a few pieces, seemingly loose bowlders, of coarse-grained and apparently pretty pure crystalline limestone. This is called the "Loomis Claim." Below here, and immediately at the mouth of the gulch, there is a body of soft sandstone, whose stratification, however, could not be determined.

Further up the valley, and probably on the northwest quarter of Section 31, there are soft bituminous clay shales which are not well exposed, but which seem to strike northwesterly and dip very gently, perhaps 4° or 5° southwesterly, and a small quantity of black maltha seeps out of these shales at different points for some little distance along the bed of the creek.

Here also in the bed of the creek were seen some fragments of a soft and very fine-grained white marble. The barometer here read one thousand eight hundred feet.

Many claims have been located within the last few months in the hills and gulches about the Little Cholame Valley for oil, the surface showing of which, however, is on the whole extremely small.

Petroleum springs are, it is true, quite numerous through a belt at least six or eight miles in length, which seems to cross the Little Cholame Valley diagonally in a northwest and southeast direction; but the quantity which they discharge is very small. No wells have yet been sunk here, and no other work had been done up to the time of my visit (October twenty-first), except the digging of some small holes only a few feet in depth. The exposures of the rocks are generally poor; but there is evidence that they are much disturbed.

It is utterly impossible to foretell what the drill may develop here beneath the surface. But the region is an interesting one, and remarkable in the presence of the serpentine at one end of the belt and granite near the other end; and as a matter of scientific interest at least, it is to be hoped that

whether profitable or not, some wells may yet be drilled here, and complete records of them kept.

Leaving the head of the Little Cholame Valley, we wound around the southwestern flank of the range lying between the head of the Little Cholame and the Tulare Valley; gradually ascending till we crossed the summit, where the barometer read three thousand and sixty feet.

For the last two or three miles before reaching the summit, the whole country is serpentine with a good deal of jasper associated with it. But, within a quarter of a mile northeast from the summit, the serpentine disappears entirely and is replaced by unaltered sandstones.

Santa Barbara County.

There are, so far as known at the present time, no oil wells producing anything in Santa Barbara County, though several have been sunk there. But there are great deposits of asphaltum and other bituminous matters at several localities in the county. "El Rincon" Creek, some three or four miles east of Carpinteria is, for some little distance near the coast, the boundary line between Ventura and Santa Barbara Counties. At Rincon Point, on the shore, just west of El Rincon Creek, the railroad company has recently done some heavy grading in the construction of their road.

Amongst other unaltered rocks here, which dip towards the north, they have cut through a heavy body of bituminous shales, which contain a sufficient quantity of bituminous matter, so that, when once ignited, they continue to burn for a long time like the waste heaps from a coal mine—and the embankments are still burning in this style at several points along the line of the road.

The ranch of Mr. P. Clark Higgins, mentioned as the "Carpinteria bed" in the Fourth Annual Report of the State Mineralogist, is only about one mile east of the new Carpinteria railroad station. The bluffs here fronting the seabeach are fifty to seventy-five feet high. The lower portion of them consists of tertiary rocks, out of which the petroleum oozes, which strike about N. 47° W., magnetic, and dip northeasterly from 40° to 60°. These are overlaid, by a recent deposit, from ten to twenty feet thick, which lies about horizontal. This deposit consists of sand and gravel, the former sometimes very thinly bedded, and the soil on the top of the hill is a black, fine, sandy loam, mixed in places with some semi-liquid petroleum. Anywhere within one quarter of a mile or more back from the edge of the bluffs it is no uncommon occurrence for the plow to turn up bituminous matter. The underlying calcareous and bituminous sandstones and shales are, many of them, extremely thin-bedded. The outcrop of asphaltum and other bituminous matters in the bluffs extends for a distance of three quarters of a mile along the shore and to within half a mile or less of the new railroad station at Carpinteria. But towards the west the underlying tertiary rocks are broken up, and strike and dip in various directions. At the extreme west they also sink beneath the surface, and the covering of recent horizontal strata grows thicker and is filled with bitumen, so as to form a tough, sticky mass, which, in tearing it open, exhibits fine, spider-web-like, and more or less elastic threads of bitumen. It is very dirty, but probably might be used for street pavements.

On Ortega Hill, about six miles east of Santa Barbara and near half way between there and Carpinteria, Mr. H. L. Williams has drilled a well. The locality is within five hundred or six hundred feet of the seashore, and is two hundred and fifty-five feet above tide. Mr. Williams here went down four hundred and fifty-five feet. The first seventy feet was surface soil

and gravel. Then came two hundred feet of sandstone and shale, much mixed. Then struck water in a blue shale. This shale is one hundred and fifteen feet thick, and is too soft to stand without casing; then struck quartz sand, saturated with heavy black oil, twenty-four feet thick; then nine feet of blue mud containing sea shells and rotten wood; then another streak of blue shale, thirty-seven feet thick.

This shale is very close, and contains neither water nor oil. The sand above was free from water. But the oil which it contains makes it act like a quicksand, and it rose one hundred feet in the pipe. Below the last shale, another body of sand was struck, much like the first, but containing a much lighter oil, and in greater quantity. This sand also acts like quicksand, and they did not penetrate any depth into it, but only just struck the top of it.

In attempting to draw the casing in order to substitute drive-pipe for it, the casing parted in the upper sand, and they could not get the lower part of it out, and were therefore obliged to abandon the hole. Then they swung the derrick around about ten feet, and started another one. This hole is now down (August third) three hundred and ninety-two feet. In the old hole, the first oil was struck at three hundred and forty-two feet; in the new one at three hundred and thirty-six feet six inches. But the first sand was struck at the same depth in both holes, viz., at three hundred and eighty-five feet.

About a quarter of a mile east of here, on the flat at the foot of the hill, a well was sunk about ten years ago to a depth of probably about one hundred and eighty feet. It is said that in this well they also struck quicksand with oil, but no rock at all.

Just northwest of Ortega Hill, in the Montecito Valley, two little creeks join, and just below their junction there is a small outcrop of asphaltum in the bank.

About three quarters of a mile northeast of the well there is a seepage of oil marked on an old map made by the County Surveyor of Santa Barbara County some twenty-five years ago, but Mr. Williams has never seen it.

At the foot of the hills, on the shore, a quarter of a mile east of the well, the rocks are exposed at low water, and it looks as if there were an anticlinal fold here. There is also some seepage of oil from these rocks, and Mr. Williams states that after a slight earthquake shock one night in 1883 a jet of oil "as large as a man's arm" spurted out here for a little while, but did not last long. Considerable gas also escapes from these rocks. Their strike is about east and west. Mr. Williams' wells are just about on the line of the anticlinal axis in these rocks, while the old well at the foot of the hill is on the north side of it.

A little over one mile east of here a low bluff makes out a short distance into the sea, and there also is some seepage of oil. There are also said to be extensive seepages in "Oil Cañon" and one other cañon in the Santa Ynez Range of mountains, some three miles in an air line northeast from Ortega Hill.

In 1885 the "Santa Barbara Oil Company" sank two wells some five hundred or six hundred feet deep in "Oil Cañon," at a point one thousand four hundred or one thousand five hundred feet above tide. There was much gas here. But at last, either by accident or malice, the tools were lost in one of the wells and the work was abandoned.

It is also said that about three or four miles north of Carpinteria a well was sunk about five hundred feet, and was then purposely and maliciously plugged and destroyed by somebody dropping a reamer into it bottom end upwards.

Moore's Landing is near the village of Goleta, about seven miles west of the city of Santa Barbara. Easterly from the landing, for a distance of a mile or so along the shore, the bluffs are forty to seventy-five feet high, of light gray sandstone, which generally dips 10° to 15° towards the northeast, though in some places it lies very nearly level. In this sandstone there are enormous quantities of asphaltum, which occurs in all imaginable forms. There are occasional well defined *veins* of it, from the thickness of a sheet of paper up to two or three feet thick, which extend for short distances through the heavy-bedded sandstone, and then run out completely. Again it occurs in heavy masses twenty or thirty feet and more in diameter. In some places very heavy beds of it run nearly parallel with the stratification of the sandstone, while on the other hand many of the small *veins* of it cut straight through and across the bedding at all angles. Most of it is largely mixed with sand and pebbles; but there are large quantities of it which look very pure. No liquid oil is visible here, nor any soft pitch either, except what is washed up in small flakes by the surf on the beach from beneath the waters of the sea.

Something like a mile to the west of the landing there is a place in a creek in the salt marsh where a good deal of gas bubbles up; and two or three miles farther southwest is Salinas Point, which projects some distance into the sea, and about half a mile outside of which is one of the large and famous petroleum springs beneath the ocean. The depth of the water where this spring issues was asserted by one man to be only about fifty feet, but by another one to be fifty fathoms. The latter is more probable. About eighteen miles off shore here in the channel, and some two miles north of the island of Santa Cruz, there is also said to be another very large oil spring under the water.

Both tin and quicksilver are reported to exist in the mountains north of Santa Barbara.

Mr. H. C. Hobson, of San Luis Obispo, states that there are very large quantities of asphaltum on the Sisquac Ranch, in the northern part of Santa Barbara County, on one of the upper branches of the Santa Maria River. Sisquac Creek joins the Santa Maria River at Fugler's Point, some fifty miles south of San Luis Obispo.

San Bernardino County.

Going east from the Puente and Petrolia wells of Los Angeles County, the range of hills widens out and covers a broad area extending east a considerable distance into the Chino Ranch in San Bernardino County, and southeast as far as the Santa Ana River, their highest summits ranging from one thousand two hundred to one thousand four hundred feet above the sea. They everywhere consist of unaltered tertiary sandstones and shales, with occasional beds of coarser grits and conglomerates, all of which have been upturned and tilted at greatly varying angles of dip, and in many places much crushed and broken. At a point not far from a mile northwest of the Petrolia wells, Bréa Cañon forks into two branches of about equal length, the southernmost of which heads in the eastern edge of the hills on the Chino Ranch, and the other one a mile or two further north.

San Antonio Creek, coming out of the San Gabriel Range of mountains, flows south into the valley, where it usually sinks. But in times of heavy freshets, it continues on entirely across the valley to Chino Creek, which, running southeasterly across the Chino Ranch, empties into Santa Ana River.

The original Chino Ranch lies entirely in San Bernardino County, the western boundary of the grant forming at this locality the county line between Los Angeles and San Bernardino Counties.

This ranch is now the property of Mr. Richard Gird, who has also purchased a large area of what were formerly Government lands lying in the hills immediately to the west of the ranch in Los Angeles County. Within the limits of this very extensive property, which was visited during the month of December, there are several localities where asphaltum and petroleum occur; though no wells have yet been drilled here for oil. Before describing these localities, however, it may be stated that in Bréa Cañon above where it forks, the surface showing of asphaltum seems to be entirely confined to the southern branch of the cañon, where large patches of it are scattered along for some distance above the forks, while none of it was seen anywhere along the north branch. This "Bréa Cañon"—as stated elsewhere in this report—is really the upper portion of Coyote Creek, a stream which runs southwesterly to the bay of San Pedro.

In the eastern and northeastern portion of this region of hills, fronting towards Pomona and the Chino Ranch, though the exposures of the rocks are not numerous and usually not very good, yet so far as could be judged, they do not seem to be quite so badly contorted and crushed as they are in some other localities, and the prevailing or most frequent strike is northeasterly, with a northwesterly dip.

The Chino Ranch House is in the edge of the valley at the eastern foot of the hills, about seven and a half miles southeasterly from Pomona. It is on Section 28, T. 2 S., R. 8 W., S. B. M.

The first bituminous locality visited on the Chino Ranch was in a small gulch, a little southeast of the head of the south fork of Bréa Cañon, and not far from the corner between Sections 23, 24, 25, and 26, T. 2 S., R. 9 W. Here a bed of bituminous sandstone, some twenty feet thick, is exposed, striking about N. 10° W., magnetic, and dipping 12° or 13° to the east. The aneroid barometer here read eight hundred and eighty feet. The rock is, most of it, rather a coarse-grained sandstone containing much mica. So far as visible it is not rich in bitumen, being generally brown instead of black in color. There is no liquid petroleum or pitch to be seen here now, and scarcely any asphaltum, though a very little oozing has taken place at some time in the past at two or three points along the gulch.

The second locality was on the S.W. ¼ of Section 25, T. 2 S., R. 9 W., at the head of a little gulch which runs south to "Carbon Cañon," the latter lying to the south of Bréa Cañon, and running westerly for several miles till it comes out into the Anaheim Valley, just south of the Petrolia wells. Here the barometer read one thousand one hundred feet; and there is a bed of bituminous sandstone exposed at least ten or twelve feet thick, which strikes about N. 60° W., magnetic, and dips northeast. The exposure was not such as to permit of an accurate determination of the angle of dip, but it probably is between 15° and 20°. Much of this rock seems to be fully saturated with bitumen, and would probably make a good street paving material. Immediately underlying this sandstone is a bed of shale some three feet thick, out of which there is some seepage of liquid petroleum at various points. Beneath this comes another bed of sandstone in which only the cracks and seams are filled with petroleum, the rest of the rock containing little or none of it; while in the upper sandstone the bitumen saturates the whole mass of the rock. The length of the exposure here along the strike is some four hundred or five hundred feet. At one point forty or fifty feet higher up the hill another heavy bed of bituminous rock is also exposed. This, however,

does not seem to be so rich in bitumen as the lower bed. This would seem to be a promising locality in which to drill for oil.

A third locality visited is probably on the S.W. ¼ of Sec. 32, T. 2 S., R. 8 W. It is in and near the head of a little gulch about one quarter of a mile southwest of the old "Stewart house," and the aneroid read seven hundred and fifty feet.

There is nothing liquid visible here now, except a very little water. But in the past, several small petroleum springs have produced a deposit of asphaltum some four or five feet in width, and stretching some forty or fifty feet along the bed of the gulch. The rocks at this particular spot are not exposed. But in the bluff about seventy-five feet to the northeast, there is a poor exposure of sandstones which seem to strike about north, magnetic, and dip some 45° to the west; though this is somewhat uncertain. At a point about one hundred and fifty feet southwest of the springs, very heavy-bedded sandstones, with a streak of shale running through them, strike N. 65° E., magnetic, and dip 35° to the northwest. This course and position would make the streak of shale overlie the beds from which the petroleum has issued, but with no great thickness of rock between them. The sandstone immediately underlying the shale is slightly bituminous so far as exposed. At a point on top of the hill about one quarter of a mile S. 20° W. from the springs, sandstones and shales strike about N. 45° E. and dip 20° to 35° to the southeast.

A fourth locality is near the old "Frenchman's house," on the S.W. ¼ of the N.W. ¼ of Sec. 5, T. 2 S., R. 9 W. Here in the gulch just opposite the house, there is a very minute seepage of oil from bituminous sandstones which strike northeasterly and dip northwesterly, and a very little asphaltum has formed here, but its quantity is extremely small.

Rice's Cañon is in the southwestern part of Mr. Gird's property, and runs southerly towards the Santa Ana River. Mr. Rice's house in this cañon was blown into small fragments and scattered over five or six acres of ground by the wind during the night of December thirteenth and fourteenth. From half a mile to a mile below where the house stood, thin-bedded and slightly carbonaceous shales are exposed in the hills along the left bank of the cañon. The best exposure, which is also the upper one, is about one hundred feet in length, and shows a thickness of ten or twelve feet of extremely thin-bedded, fine-grained, sandy, and slightly carbonaceous shales, which strike nearly east and west, and dip very gently, perhaps 4° or 5° to the north. These are overlaid by ten or twelve feet more of alternations of shales and sandstones, above which the rocks do not show. The lower shales contain much gypsum, which occurs not only in little bunches and in thin sheets running parallel with and intercalated between the layers of the shales, but also frequently in the nature of little veins, rarely over one fourth of an inch thick, which cut through the stratification at all sorts of angles. There are two or three exposures of the same rocks farther down the cañon, but none of them so good as this one.

Santa Clara County.

About one fourth of a mile westerly from Mr. J. P. Sargent's house, a few miles southwest of Gilroy, there are some tar springs, and a well was sunk in the first part of 1887, about two hundred and fifty feet deep, with no other result than a little sulphur water, a little gas, and a very little thick, black, tarry oil. The tar issues from a bituminous sandstone, much of which is full of fragile fragments of *Turritella* and other shells. But immediately north of the well, and within fifty feet of it, is the outcrop of a heavy

body of serpentine. The sand rocks are not well enough exposed to show their strike and dip.

About two miles farther up Tar Spring Creek (barometer at 9:45 A. M. read four hundred feet), there is an area of some three or four acres, which is chiefly covered with asphaltum and very copious seepages of black tar, like those in the Ojai Valley. The rocks here seem to be sandstones and breccias, which are not, however, well enough exposed to show their strike and dip, and are generally covered with adobe soil. I saw here within a radius of fifty feet, the carcasses of one yearling, four calves, and two skunks, which had got stuck in the pitch, and died there.

Afterwards on the other side of the gulch I saw in a pool of pitch the carcass of a one or two-year old colt. There are scattered tar springs for half a mile above here along the gulch. From the head of this gulch we crossed over the hill to Pescadero Creek, down which we came, stopping at the sulphur springs (cold, white) on the way. Mr. Sargent states that about one mile farther up Pescadero Creek than the point where we struck it, there is another bunch of tar springs, not so large as the one we saw, but accompanied by a deposit of asphaltum, which is purer and of better quality. In the gulch, a short distance above the group, which we saw on Tar Spring Creek, very fine-grained and nearly white sandstone strikes about east and west and dips 70° to 90° to the south. Mr. Sargent has a chromic iron mine in Penitencia Gulch, a few miles out and northeast from San José.

In Moody's Gulch, which is a branch of Los Gatos Creek, at Wells Nos. 1 and 2, which are only about one hundred feet apart, the gulch runs about N. 20° E., magnetic. Barometer here read one thousand one hundred feet. At the bridge, a little above here, fine-grained sandstones and shales strike about N. 60° W., and dip about 65° S.W. Within two hundred feet east of this bridge, and seventy-five feet or more above the bed of the gulch, is Well No. 4. About one hundred and fifty feet farther east, and still higher up the hill, is Well No. 5. East of this, and yet higher, is Well No. 8, which is still drilling. On the opposite side of the gulch, and about two hundred feet from it, is Well No. 7. Northwest of No. 7, and some three hundred feet distant from it, is "Logan, No. 1." They are now making preparations to drill "Pyley, No. 1," about three hundred feet S. 20° W. from "Logan, No. 1." Barometer at "Logan, No. 1," at 1:45 P. M., read one thousand three hundred and twenty feet. All the oil obtained here is said to be green oil of about 44° B. It is piped a distance of about one mile from the wells to the railroad station.

The tank to which the oil is piped is at the mouth of Moody's Gulch, right opposite the "Half-way House," kept by Mrs. H. F. Riecke. She says there is much oil around the mouth of the cañon. Also, she has a well at the house, forty feet deep, from which they can not drink the water because of the oil.

Mr. R. C. McPherson, Superintendent and Manager of the oil wells in Moody's Gulch, says that he was the first man who ever drilled a successful deep oil well in California, and that this well was drilled in 1875, in Pico Cañon, Los Angeles County. Exactly which well it was, could not be learned—for some of the wells have changed names; but it was probably one of the three now known as "Pico, No. 1," "Pico, No. 2," or "Pico, No. 3."

Mr. McPherson kindly furnishes the following information concerning the wells in Moody's Gulch, from records kept by him.

"Moody, No. 1," struck oil at about eight hundred feet. No further record of it is available.

"Moody, No. 2" was drilled in October, 1879. It started in slate with streaks of rotten sand. At three hundred and eighty feet, better sand twenty-five feet thick. Afterwards ran in slate and shale, until striking second sand at six hundred and thirty feet, twenty feet thick, with oil all through it. After this, sand very shelly * with streaks of shale and slate. Struck third sand at seven hundred and sixty-five feet. Well began to fill up with oil. Drilled her eight hundred feet. Pumped her here thirty barrels per day.

"Moody, No. 3" was sunk to a depth of one thousand and eighty feet, and showed some oil and gas at that depth; but she then caved in and was lost.

"Moody, No. 4" was sunk in August and September, 1880. Started in shale and soft sand. At two hundred and sixty feet, struck first regular sand thirty feet thick. Afterwards, streaks of slate and shale until reaching second sand forty feet thick at depth of six hundred and eighty-five feet. Then streaks of slate, shale, and shells. Struck "stray sand" twenty feet thick, dark gray in color, at depth of nine hundred and eighty feet, carrying considerable oil. Believe at this depth in this case she would pump ten barrels per day. After this sand, ran through hard shelly formation all the way until reaching third sand at one thousand and forty feet. This sand is first class oil-bearing sand carrying pebbles. On sinking "one screw" (*i. e.*, five feet) into this sand, she began to fill up rapidly, and within twenty-four hours there were three hundred feet of oil in the hole. At one thousand and fifty-five feet, struck more oil which seemed to be increasing very rapidly. At one thousand and seventy-five feet she made her first flow. At one thousand and eighty-five feet she flowed one hundred barrels per day, flowing nearly all the time. From here to one thousand and ninety-five feet, the sand grew finer and harder. Drilled to one thousand one hundred and three feet, still in the same sand. As the well was flowing in such manner, concluded to stop at this depth. Within the first ten days, she flowed one thousand and twenty-five barrels.

"Moody, No. 5." Started in slate. Struck first sand rock, twenty feet thick, at depth of four hundred and sixty-five feet. After this ran in slate and shale till at the depth of six hundred and thirty feet, struck second sand ten feet thick. Then ran in shale to nine hundred and thirty feet, where we struck the third sand fifteen feet thick. The well made two flows. Pumped her for awhile, but she proved a small well, yielding only about ten barrels per day. Concluded to drill her deeper. Went through slate all the way to one thousand four hundred and twenty-five feet. No change. Shut her down, and pumped her at seven hundred and thirty feet, pumping ten barrels per day. No increase by drilling her deeper.

"Moody, No. 6." Showed a little oil at one thousand one hundred and twenty feet. Went one thousand four hundred feet deep, but was never pumped.

"Moody, No. 7." Drilled in 1880. Started in slate. First regular sand twenty feet thick, at two hundred and seventy-five feet. Then ran in shale and slate until striking second sand fifty feet thick at six hundred and twenty-five feet. Afterwards in slate, shale, and shells. At nine hundred and fifty feet struck "stray sand" fifteen feet thick, with some oil in it. After this, very shelly, with shale and streaks of slate. At one thousand and fifty feet, fifteen feet of hard shells run into twelve feet of slate. Afterwards shell and sand. More sand, with oil and gas. At one thousand

---

* I may as well state here that I do not know exactly what is meant by the word "shelly" in this connection. I do not think it always means a rock containing shells. I suspect that it relates to the structure of the rock, and that *shaly* might be a better word. G.

and ninety feet, better sand with more oil. At one thousand one hundred feet, well began to fill up with oil. At one thousand one hundred and twenty-five feet, pumped her thirty barrels per day. Afterwards drilled her to one thousand two hundred feet, and increased her at that depth to forty barrels.

"Logan, No. 1." A twelve-inch hole. Drilled in 1880. Started in slate and sand. Struck first sand twenty feet thick at two hundred and eighty feet. Then slate and shales to second sand, thirty feet thick, at six hundred and fifty feet. Then shale and shells mixed. At eight hundred and eighty-five feet, "stray sand" with some oil and gas. Afterwards more shells with streaks of sand. At nine hundred and fifty feet, more sand and better. At nine hundred and eighty feet, well filling with oil. Two hundred feet of oil in her. At one thousand feet, filled with oil. Put tubing in and pumped fifteen barrels per day. Drilled her to one thousand one hundred feet and increased her some. Sand all the way.

It should be stated here that the foregoing information so kindly furnished by Mr. McPherson regarding the Moody's Gulch wells was not written by him, but by some one in his employ, and whom he trusts. The whole thing is copied almost *verbatim* from the notes which Mr. McPherson furnished. It is evident enough from the terms and phraseology employed, especially those of the "first," "second," "stray," and "third" sands, so frequently used, that the writer is a man who is familiar with oil wells in the East, and whether he knows anything of the geology of California or not (a question which I will not discuss here), the facts which he gives are very valuable, and ought to be placed on record. It is rare that so full a record as this is obtainable of any wells yet drilled in California.

Under date of December 19, 1887, Mr. McPherson states that the well called "Pyley, No. 1," is now three hundred and eighty feet deep. It first passed through seventy-three feet of "rotten rock," and then through sandstone to a depth of one hundred and eighty feet, where a band of slate two feet thick was found; then soft sandstone to the depth of two hundred and twenty feet; then two feet more of slate, and then sandstone to the bottom, the last ten feet of sandstone being very hard. The well already yields some gas and a little oil.

Santa Cruz County.

Mr. I. L. Thurber's bituminous sand rock quarry, about five miles N. 75° W. from Santa Cruz, was visited August twenty-third. Barometer here at 4:30 P. M. read one thousand and seventy feet.

There is here a body of bituminous rock ten feet or so in thickness, underlaid by a moderately coarse-grained, clean, soft, quartz sandstone. The hill rises about one hundred feet to the southeast above the quarry, and no one yet knows how heavy the mass of bituminous rock may be. It lies nearly horizontal, but dips very slightly to the south. The sand of which this rock is made is chiefly quartz, like that of all the other bituminous rock yet seen in Southern California. Barometer on top of hill read one thousand one hundred and fifty feet. Rock on top of hill is a very fine-grained, white, clayey sandstone. At a point where the bituminous rock is opened up a little farther west, it shows a thickness of twenty to twenty-five feet of good material; and there are strong indications that farther back in the hill it is much thicker still. At a point about three and one half miles northwest of town, Mr. P. T. Stribbling has a gold quartz mine on the Rancho "El Refugio," near the Ben Lomond road. Here there is a shaft some

twenty or twenty-five feet deep, exposing an irregular body of quartz, in places two or three feet thick, which, in the pan, prospects richly in rather coarse gold. The country rock is a rather coarse-grained quartz sandstone, considerably metamorphosed, and containing some mica.

San Diego County.

Small prospects of petroleum and asphaltum are reported to have been found at various localities near the coast. But so far as known, no discoveries of this kind have yet been made in San Diego County which give any reasonable promise of becoming commercially valuable.

San Luis Obispo County.

From Santa Barbara the writer came by steamer August ninth to Port Harford, not stopping at this time to examine several localities where large quantities of asphaltum are said to exist in the northern part of Santa Barbara and the southern part of San Luis Obispo Counties.

At and in the immediate vicinity of Port Harford there are extensive bodies of serpentine.

At a point near the railroad in the valley of San Luis Creek, about six miles south of San Luis Obispo, and half a mile or so in an air line from the seashore, a well has recently been drilled by Judge Frank Adams and Dr. G. B. Nicholls, to a depth of nine hundred and twenty-eight feet, in quest of oil. But oil they did not get. They did, however, strike a fine flow of warm sulphur water (temperature, 103° F.); so they have built bath-houses and a hotel, and intend making a sanitarium and pleasure resort of it. Considerable hydrocarbon gas accompanies the sulphur water, which is said to have been first struck at the depth of about six hundred feet. There is an old tunnel in the gulch here above the well, which, however, never produced anything of value. The aneroid at the mouth of this tunnel read two hundred and thirty feet, while on top of the hill a short distance to the south, it read six hundred and ninety feet.

From here we traveled several miles around the ocean beach and through the hills in a general easterly direction; saw two or three little tar springs at different points in the more or less bituminous sandstones, and at last reached the great deposit of bituminous sandstone now being worked by Messrs. Adams and Nicholls on the "Rancho El Pismo," about seven miles southeast of San Luis Obispo.

Here the rocks strike about east and west, and dip about 40° toward the south. The sand and grit of which they are made up are chiefly quartz of various colors, and the different strata vary in character from extremely fine-grained sandstones to a somewhat coarse grit, which is filled with very smoothly water-worn little quartz pebbles, the largest of which are about half an inch in diameter.

Great quantities of all these rocks at this locality are saturated with bitumen. There are, it is true, places where the rock is free from bitumen, and other places where the percentage which it contains is small. But the greater portion of it, where the quarry has been opened, is about as full of bitumen as it can hold, and the quantity easily available here is practically inexhaustible. A short sidetrack from the Pacific Coast Railroad runs directly to the quarry. The latter, at the time of our visit (August eleventh), presented a face thirty to forty feet high and one hundred feet or more in length. Blasting is required, and the quarrying is at times

not altogether a safe business; for the rock is extremely tough, and a heavy shot often shatters much more than it actually throws down, and in such a case the shattered portions will continue to cling for awhile to the face of the cliff, though slowly and gradually pulling themselves away from it all the time, till they at last drop suddenly and without warning, sometimes in blocks of many tons at a time. They are now shipping this rock both to Los Angeles and San Francisco for street pavements, for which it seems to be admirably adapted. The present cost of freight to either Los Angeles or San Francisco is about $6 per ton. And the contract price, which they receive for street pavement laid in the City of Los Angeles, is 25½ cents per square foot, the contractors agreeing to keep the pavement in order for five years without further cost to the city. Casts of several fossil species of marine shells are not unfrequently found in the richest bituminous rocks of this quarry.

At a point about three quarters of a mile S. 53° E. from Messrs. Adams & Nicholls' quarry, there is another large deposit of bituminous sandstone, very heavy-bedded, but which seems to strike about N. 65° W. and dip some 40° to the northeast. This locality is called "Oak Park." It is owned by Captain C. B. Johnson and L. M. Warden, and is on the "Corral de Piedra" ranch. It is close alongside the railroad and close to the foot of a high peak, with a nearly vertical bluff which faces the southeast and which seems to consist of similar sandstones and grits, striking and dipping in about the same directions, and almost all of them more or less bituminous. But very little work has yet been done at this locality, and the exposures are not so good as might be desired.

Mr. J. J. Schiefferly also has a ranch of one thousand three hundred and forty-four acres, about one mile westerly from Adams & Nicholls' quarry, where the hills are, most of them, full of bituminous sand rock. There is probably enough of this material within an area of a few square miles in this vicinity to pave all the cities of the United States. There is also on Mr. Schiefferly's ranch a large quantity of infusorial siliceous rock, which strikes N. 76° W., magnetic, and dips 45° southwesterly. A piece of this rock presented to the Bureau by Mr. Schiefferly effervesces with acid, and therefore probably contains some lime. The block measures twenty-eight inches by twelve inches by six and one half inches, and weighs ninety-three pounds. Its specific gravity is therefore about 1.188. Mr. Schneider found in it, under the microscope, some diatoms and some spiculæ of sponges.

Mr. H. C. Hobson, of San Luis Obispo, states that there are also great quantities of infusorial silica near the residence of Don Juan Arianos, not far from the coast, on the old "Coast Road," between Point Sal and Los Alamos.

Mr. A. B. Hasbrouck, whose Post Office address is "Music, San Luis Obispo County," owns a ranch called "Ranchito" in the Santa Lucia Range of mountains, about twenty-two miles southeast of the city of San Luis Obispo and on the headwaters of the Arroyo Grande. He states that on his place there are large quantities of asphaltum, with some petroleum springs and much sulphur water. Some of the sulphur springs are warm and some are cold. He also states that the so called "onyx" locality is about twenty-seven miles southeast of town. This material, some of which is very handsome, is, however, not "onyx," but arragonite. Some cinnabar is also reported to have been found there, and there are said to be large quantities of the great fossil oyster, "*Ostrea Titan*," together with *Pectens* and numerous other fossil shells. But this locality was not visited for lack of time.

Don Luis Flores lives on the southern flank of the Santa Lucia Range of mountains, about one thousand six hundred and fifty feet above the sea and at a distance of about four miles in an air line, or six and one half miles by the wagon road, N. 30° W. from San Luis Obispo. On first striking the hills we find a broad belt of serpentine, then calcareous rocks and shales with geodes of chalcedony and jaspery quartz, etc.; then some sandstones, and then another belt of serpentine, in which some chromic iron occurs. I went northerly from Flores' house to the summit of the Santa Lucia Range, which is here about two thousand five hundred feet high, thence easterly for some distance along the crest, and afterwards down around the southern flank of the range, back to the house. The whole top of the range here is serpentine. Small quantities of chromic iron were seen in many places, but no very large body anywhere. At the "Pick and Shovel" mine, however, a tunnel has been driven about five hundred feet into the hill, and struck, near its face, a body of ore from which a considerable quantity (it is said two thousand to three thousand tons) has been shipped. This region is about the head of "El Chorro" Creek.

The porphyry of which the Court House steps in San Luis Obispo are made, is a good and durable building stone. It came from Charles Lee's ranch, at the foot of the "Picacho de Romualdo," about four miles N. 75° W. from the city. Course from here to Don Luis Flores' place about N. 10° E., magnetic. The whole mass of the Picacho de Romualdo consists of the same kind of rock. It is several hundred feet high, and is a very sharp cone. It is about one and one half miles westerly from "Obispo" Peak. "San Luis" Peak is east of "Obispo" Peak, and between it and the city of San Luis Obispo. All these peaks consist of the same kind of porphyritic rock. "El Moro" also probably belongs to the same eruptive group which comprises all these conical hills running from "El Moro" southeasterly for many miles through the valley, to and beyond San Luis Obispo, including "Romualdo," "Obispo," "San Luis," "Buena Vista," and other hills.

Took aneroid barometer readings on stage trip from San Luis Obispo to Templeton, as follows:

At San Luis Obispo	310 feet.
At El Salto	700 feet.
At Summit	1,540 feet.
At Bean's	1,280 feet.
At Pat Murphy's ranch	1,080 feet.
At watering place	1,000 feet.
At Templeton	910 feet.
At Paso Robles	850 feet.

The warm sulphur springs at Paso Robles are said to discharge about four thousand five hundred gallons per hour.

San Mateo County.

September twelfth, took stage from San Mateo to Spanishtown and Pescadero. On the road going down the hill from the summit into the cañon of Pilarcitos Creek toward Spanishtown, there is a large body of rather soft, decomposed granite.

Distances on the road are stated as follows:

From San Mateo to Spanishtown	14 miles.
Thence to Purissima	4 miles.
Thence to Lobitas	2 miles.
Thence to Tuñitas Creek	1 mile.
Thence to San Gregorio	5 miles.
Thence to Pescadero	7 miles.
Total	33 miles.

Reached Pescadero at 4:15 P. M.

Part of the way along the coast are broad benches of recent strata lying nearly horizontal, and ending in precipitous bluffs on the beach. Between San Gregorio and Pescadero the road runs over the hills a mile or so back from the shore; and there are many exposures here of partially metamorphosed shales and blocky sandstones, which in places are more or less broken up and crushed, and sometimes dip northwest or north, though their prevailing dip seems to be northeasterly towards the axis of the range. The angle of the dip generally ranges from 30° to 50°.

On Tuñitas Creek, about two miles east of Lobitas, four wells have been sunk to different depths. No. 3 is lowest down the creek. It was commenced in June or July, 1885, and finished in September, 1886, to a depth of about eight hundred feet. When it was about three hundred and fifty feet deep, they pumped for awhile from it about two and a half barrels per day of a dark green oil, with gravity 49° or 50° B.

No. 1 is just above No. 3. It is about five years old, and is nearly six hundred feet deep. When it was first sunk they used to bail from three to five barrels per day from it.

No. 2 is a little farther up the cañon than No. 1. It was sunk about four years ago, and is a little over five hundred feet deep. It showed some oil, but never yielded much. All three wells are within a distance of one hundred and fifty or two hundred feet. They are all of them idle now. The rocks sunk through were soft shales, with an occasional little streak of sandstone, but no large body of it.

About half a mile above here there is another well, sunk about three years ago by Messrs. Bodwell & Dewey, of San Francisco, to a depth of about six hundred feet. This well is said to have shown a little oil, though it was substantially a dry hole. The above information is from Mr. David White, who lives at the wells. Barometer at his house, one hundred and thirty feet. The property is in litigation and nothing has been done here now since last May. Just above Well No. 1, very soft clay shales strike about N. 50° W. and dip about 35° S.W. These wells furnished considerable gas, about enough to make the requisite steam for pumping. It was also used for domestic purposes in the house. About one hundred yards below the wells there is a small white sulphur spring coming out of a somewhat hard clay-rock which strikes N. 55° W. and dips 30° S.W.

About one quarter of a mile below the wells, and just below the bridge which here spans the creek, there are in the bluff fossil clams which seem to be identical with a species now living on the coast. About one quarter of a mile above the wells there is also another locality where they are plenty; and a few of them may be found here and there all the way between.

On Purissima Creek, about one mile from the village of the same name, a well has been sunk, with a five and five-eighths inch casing, to a depth of seven hundred and seventy-two feet. Struck first oil at two hundred and forty feet. The well was begun in April, 1884, and sunk five hundred and seventy feet, at which depth it remained for awhile, but was afterwards sunk two hundred feet deeper. It has been standing idle now since

October, 1885. The largest yield when pumping was about four or five barrels per day. They have pumped, however, but very little. There is a two hundred and sixty-five-barrel tank here. While sinking the last two hundred feet, they used to take out about two barrels of oil with the sand-pump each morning, which sufficed to run the engine through the day. This is known as "Lane's Well." The oil is of about the quality as that in Tuñitas Cañon. It is said that over $10,000 were expended here. There is no asphaltum here, but there are slight seepages of oil along the creek. The rocks do not show on the surface, but Mr. Schurtz states that they consist of shales of varying hardness, though generally rather soft, and that they dip to the southeast or south. There are sulphur springs also in this cañon, both below and above the oil well. All of them are cold. They struck some fossil clam shells in this well itself, at the depth of about two hundred and forty feet. William Schneider, 1230 Mission Street, San Francisco, is the man who drilled this well, and he is said to have a record of it. The clams are the only fossils that Mr. Schurtz knows anything about in this cañon. Some fossil bones of whales and large land animals are said to have been found in Tuñitas Cañon. Mr. H. Dobbel says that at a point about three miles south of Spanishtown, and only some three hundred or four hundred feet back from the seabeach, David Gottmann, of San Francisco, about two years ago sunk two wells, one about six hundred feet deep, and the other about three hundred feet deep, but found nothing of any value, though some oil oozes out all the time at various points along the beach.

Ventura County.

The oil region of Ventura County lies in the mountains to the north of Santa Clara River, and stretches from about the eastern boundary of the county westerly as far as the San Buenaventura River. The wells are mostly situated from three to six miles north of the edge of the Santa Clara Valley, in and about a series of cañons which run southerly to the Santa Clara River. The names of these cañons in order, from east to west, are as follows: Piru Cañon, Hopper Cañon, Sespe Cañon, Santa Paula Cañon, Adams Cañon, Saltmarsh Cañon (a branch of Adams Cañon), Wheeler Cañon, West Wheeler Cañon (a branch of Wheeler Cañon), Sulphur Cañon (a branch of the Cañada Larga), Coche Cañon (a branch of the Cañada Larga). There are also a few wells in the Ojai Valley.

Westerly from Santa Paula Creek, between the Ojai Valley on the north and the Santa Clara Valley on the south, there extends an unbroken mountain ridge whose highest crest is about two thousand feet above the sea, as far west as the San Buenaventura River. This ridge is called "Sulphur Mountain," and all the cañons above named to the west of Santa Paula Cañon lie on the southern flank of Sulphur Mountain.

This region was carefully examined, and in describing it the various cañons will be taken in order as above from east to west, beginning with the most easterly one.

PIRU CAÑON.

From Camulos Station it is about two miles westerly to the mouth of Piru Cañon at the railroad bridge. From there it is about two miles northerly up Piru Cañon to the mouth of Bréa Cañon, and thence about two miles westerly up Bréa Cañon to the well of Messrs. Rhodes & Baker, which is situated in the latter cañon close to the head of it.

There is here exposed a well defined, sharp anticlinal fold in the rocks, whose axis runs about N. 77° E., magnetic. On either side of this axis the rocks dip north and south at angles of 45° to 50°.

The well is about two hundred and fifty feet north of the anticlinal axis, and is now (July twelfth) seven hundred and fifteen feet deep. It is in sand rock all the way down. At the depth of three hundred and thirty feet they struck water with a little oil, which continued down to the depth of five hundred feet; below which, to the present bottom of the well, they have had dry sand rock, with neither water nor oil. The water contains some salt, and probably also some sulphur. They have stopped drilling this well for awhile, because their water supply for the engine gave out. There is a moderate quantity of gas in the water from this well.

From two hundred to three hundred feet south of the well, *i. e.*, about on the line of the anticlinal axis, there is an extensive deposit of asphaltum mixed with surface sand, and numerous little springs of black maltha scattered over perhaps an acre of ground. The oil from the well is dark brown in color.

This is said to be the only well in or about Piru Cañon. And certain it is that in the Piru Cañon itself the visible surface indications of bituminous matters are very slight.

In Bréa Cañon, about half a mile below the well, there is a strong sulphur spring; and a short distance farther down there are two or three small patches of asphaltum, and one place where a little liquid petroleum issues from the bank a little above the road.

Next west of Piru Cañon comes—

HOPPER CAÑON.

At the mouth of Hopper Cañon, not far from Buckhorn Station on the railroad, a well was drilled in 1877, by M. W. Beardsley, to a depth of three hundred feet. Except about ten feet of surface gravel, this well was in solid sandstone all the way down. Water was struck, with some light oil, at about one hundred and fifty feet. The well was sunk to this depth by contract, and the work was then stopped because the company had no further funds with which to go deeper. Mr. Hugh Waring states that Mr. Beardsley afterwards said to him that if, even at that depth, the water had been cased off, and the well pumped, it would probably have yielded three or four barrels per day of light green oil. From this well, in an air line, a little east of north, to the other wells in this cañon, is about one and one half miles; but, following the windings of the cañon, it is probably at least two and one half. Here are two wells about two hundred feet apart. The lower one is ninety feet deep, and was abandoned because the hole became irretrievably crooked. There was here a good deal of heavy black oil. The other well is a new one just started, and is now (July fourteenth), only thirty feet deep; yet they have a little heavy black oil on the tools even now.

All the way from here down to the mouth of the cañon there is liquid oil floating on top of the water in the creek. Some of it is green, and some of it is black. The aggregate quantity of oil which thus oozes out and floats away on the water is of course not large, nevertheless it is greater in this cañon than in any other cañon yet seen in Southern California.

The general rule as to the strike of the rocks in this vicinity seems to be that it lies somewhere between east and west, and northeast and southwest; yet it often goes outside these limits in both directions. As to the dip, it is

impossible to describe it better than by saying that at different points it is in both directions and at all possible angles.

In fact, the heavy masses of unaltered sandstones and thin-bedded shales are everywhere crushed and thrown into short, sharp folds, with frequent breaks and faults, like masses of crumpled and torn paper, and the confusion is indescribable. Sulphur springs are numerous, and close by the upper wells there is a nice soda spring in the right hand edge of the bed of the cañon.

Rhodes & Baker's well, above described, in Bréa Cañon, is nearly due east from here, and distant in an air line over the hills only about one and one half miles.

About two and one half miles farther up Hopper Cañon there is said to be a large deposit of asphaltum and also a considerable discharge of heavy black petroleum. In an air line, the distance, a little east of north, would be only about one and one half miles. The air-line distance westerly across the hills to the Sespe Cañon is said to be about three miles.

The old well at the mouth of Hopper Cañon is on the S.E. ¼ of Sec. 23., and the two upper wells are on the N.W. ¼ of Sec. 13, T. 4 N., R. 19 W., S. B. M.

Waring's house is perhaps one fourth of a mile east of the mouth of Hopper Cañon.

About opposite Waring's house, in the hills on the south side of the Santa Clara Valley, on the Simi Ranch, and on the northern slopes of the San Fernando Range of mountains, there is a large deposit of asphaltum, together with extensive outflows of liquid petroleum, where some years ago a man gathered for awhile about ten barrels of oil per day. Oil men believed that, with the expenditure of a moderate amount of labor, a surface flow of forty barrels per day could be obtained there. This information is from Mr. Hugh Waring, who further states that this is the most westerly point where asphaltum is found in the San Fernando Range. He also says that east of there, in the hills somewhere to the south of Camulos, he has seen cattle mired and dead in pools of viscid and muddy maltha.

SESPE CAÑON.

Sespe Creek, occupying the cañon next west of Hopper Cañon, is the largest and longest northern branch of the Santa Clara River in Ventura County. It heads far back in the mountains, to the north of the Ojai Valley, and at first flows nearly east for a number of miles, passing entirely around the head branches of Santa Paula Cañon and then curves around so that its general direction for the last ten or twelve miles of its course in the mountains is nearly south. The mouth of the cañon is something like ten miles east of the town of Santa Paula. "Tar Creek" and the "Little Sespe" are two different branches of the main Sespe Cañon, both of them coming in from the east, the mouth of Tar Creek being several miles above that of the Little Sespe. The latter is a short cañon, not more than four or five miles in length, but Tar Creek is a longer stream, and heads in the extremely rough region to the north of the head of Hopper Cañon.

From Santa Paula, by a good wagon road, to the mouth of Little Sespe Cañon, the distance is called fifteen miles. Then, up the Little Sespe itself to the locality of the old "Los Angeles Wells," is a distance of two or three miles, and from there to the new wells, on the upper branches of "Tar Creek," is some five or six miles more over a rough country, and a mountain road which, though built for wagons, nevertheless has, for considerable distances, grades which exceed *one foot in four*.

These new wells were visited July twenty-fourth. On that date the aneroid barometer at the wells, at 11 A. M., read two thousand three hundred and seventy feet above the sea.

Near the mouth of the main Sespe Cañon one small oil spring occurs in the bed of the cañon. In the "Little Sespe" there is a nice little stream of water and occasional small oil springs and seepages.

The rocks in the lower part of the "Little Sespe" are chiefly dark brown sandstone and shales. Some of the sandstones are heavy-bedded, and would probably make a good building stone. The strata about the mouth of the Little Sespe strike and dip in various directions, the dip being generally steep and sometimes nearly vertical. Heavy bodies of them dip to the north 30° to 40°; others dip 40° to 70°, or more, to the southeast, etc.

About one quarter of a mile north of the mouth of the Little Sespe, in the main Sespe Cañon, a well was once sunk, called the "Kentuck," which is said to have been about three hundred feet deep, and to have yielded some three or four barrels per day of heavy oil. But it has been abandoned.

In the "Little Sespe" are the so called "Los Angeles" wells, of which there are two. One of these is about one thousand five hundred feet deep, and is said to have at first yielded for some time about one hundred and fifty barrels per day. But about the year 1882, in the course of a "freeze out" game amongst the owners, while still yielding some forty barrels per day, it was maliciously plugged by somebody, and thus ruined. The other one went down about two hundred feet, when the hole became crooked. A second hole was then started close alongside of it, which went down to about the same depth, when it also became crooked, and was abandoned.

The present wells of the "Sespe Oil Company" are scattered about the upper branches of Tar Creek, which runs in a general westerly direction for several miles to the main Sespe. Of these branches "Oil Creek" and "Irelan Creek" are the most important.

Well No. 1 is on the right bank of the main Tar Creek. It was begun January 26, 1887, and finished February 12, 1887; is one hundred and ninety-six feet deep, and pumps about forty barrels per day of a very dark colored greenish-brown oil. This well was in sandstone all the way down. The water was shut off at eighty-two feet. It did not flow from the mouth of the well, but would have pumped about two hundred barrels of water per day. This well first started off at about one hundred barrels of oil per day, but afterwards fell off to about forty barrels, its present yield.

Nos. 1, 2, and 4 are all nearly in a straight line, which runs about N. 20° W., magnetic.

No. 2 is about three hundred feet southeasterly from No. 1. It was drilled in April, 1887, and is two hundred and six feet deep. It first started off at about one hundred and fifty barrels per day, but afterwards fell off, and flows at this date (July twenty-fifth) about seventy-five barrels per day of dark green oil. It also produces considerable gas. The water and strata were about the same as in No. 1.

No. 4 is probably one thousand two hundred feet northwesterly from No. 1, and is a new well for which they are now sinking the "conductor hole," and have not yet begun drilling.

No. 5 is on Oil Creek, about a quarter of a mile southerly from No. 2. Here, also, they have as yet only sunk the "conductor hole," and have not begun drilling.

No. 3 is about a quarter of a mile still further south. It is now down about five hundred feet, without any valuable quantity of oil, and they are still drilling.

No. 6 is located some five hundred feet easterly from No. 1. Here the grading has been done and a few of the timbers are on the ground, but the derrick has not yet been erected.

All the foregoing statements concerning these wells refer to their condition at the time of our visit, viz.: July 25, 1887. But, under date of September 26, 1887, Mr. W. L. Hardison gives me the following information:

Sespe No. 2 has lately been pumping instead of flowing. It began to pump about August first at the rate of two hundred and twenty-five barrels per day, and is now pumping about one hundred and forty barrels per day.

No. 4 is now about four hundred feet deep and pumping twenty-five barrels per day.

Nos. 3 and 5 both went down about seven hundred feet, were both drilled entirely through the sandstone into a red rock which here underlies it, and are both dry holes.

The gravity of the oil from these Sespe wells is said to be 34° or 35° B.

There are no wells yet on Irelan Creek. But this creek forks into four or five different branches, in all of which there are patches of asphaltum and numerous tar seepages, and at the time of our visit they were building roads in there preparatory to sinking wells.

This region is an extremely rough one, the hills being very steep and generally covered with dense chaparral.

The prevailing strike of the rocks, where exposed in the vicinity of the wells, is about N. 70° W., magnetic, and their dip to the northeast from 30° to 40°. But in the surrounding higher mountains the strike and dip seem to vary considerably. In the high ridge a mile or two east of the wells, the rocks seem to dip 20° to 30°, in a direction about E.N.E.

The rocks are sandstones and shales, with occasional bands of limestone, and there are many localities where they contain fossil shells of *Pecten*, *Turritella*, etc. But these are generally very fragile, and it is difficult to get good specimens.

SANTA PAULA CAÑON.

This cañon was formerly called "Mupu Cañon." The group of wells which it contains are called the "Scott" wells, and are situated in a little branch on the west side of the main cañon, about four and one half or five miles from the town of Santa Paula. They are from three to ten years old. There were eleven or twelve of them in all, some five or six of which only are now producing an aggregate of about eleven barrels per day. They range from two hundred to one thousand feet deep. The oil is black.

ADAMS CAÑON.

From the Scott wells southwesterly over the hill to the nearest wells in Adams Cañon is a distance of about half a mile.

The Adams Cañon wells are about the head of the cañon, and most of them strung along a very narrow belt about three quarters of a mile long, which runs about northeast and southwest along the southern foot of Sulphur Mountain.

There is considerable asphaltum on the surface of the ground in Adams Cañon. The largest patch covers probably one or two acres of ground and contains numerous little springs of black maltha.

Adams Well, No. 1, was drilled as early as 1875, directly in this bed of asphaltum, to a depth of only one hundred and eighty feet. For ten years or more it produced from twenty to twenty-five barrels per day, till Well

No. 3 was drilled within one hundred and fifty feet of it, which tapped it and stopped its production.

No. 2 is about two hundred feet south of No. 1. It is two hundred feet deep and is a dry hole.

No. 3 was drilled in 1885. It is two hundred feet deep, and now produces about ten barrels per day.

No. 4 is one thousand feet east of No. 1, is five hundred feet deep, and is a small well, yielding three or four barrels per day.

No. 5 is about four hundred feet east of No. 4, is eight hundred and fifty feet deep, and is a dry hole.

No. 6 is about one hundred and fifty feet south of No. 5, is two hundred and fifty feet deep, and produces two or three barrels per day.

No. 7 is about one thousand feet south of No. 1, was drilled in April, 1886, struck oil at two hundred and forty feet, and went three hundred and ninety feet. This well at first *flowed* seventy-five barrels per day. It now pumps about fifty barrels per day. There was no water at all in this well. The gravity of its oil is 28½° B.

No. 8—also called "Wild Bill"—was begun June 3, 1886, and struck no water at all from top to bottom. Struck oil at four hundred and twenty feet, about twenty barrels per day. Second streak of oil at seven hundred and thirty-five feet. Total depth of well, eight hundred and forty feet. It started off when finished, June 29, 1886, pumping one hundred and twenty-five barrels per day, and still keeps up the same production. Gravity of oil, 28½° B. This well is one thousand five hundred feet south of No. 7.

No. 9 is some two thousand five hundred to three thousand feet northwest of No. 8, was drilled in July and August, 1886, and struck water at one hundred and fifty-five feet. Shut the water off down to one hundred and seventy-five feet. Struck heavy oil at three hundred and seventy feet capable of yielding three barrels per day. Shut that off at four hundred and fifty-four feet with a five and five eighths inches casing. Total depth of hole, one thousand two hundred and sixty-one feet. No other oil struck.

No. 10 is about one thousand feet southeasterly from No. 9, is about six hundred and twenty-five feet deep, and gave water but no oil.

No. 11 is about eight hundred feet south of No. 7. It was drilled in April, May, and June, 1887, and is one thousand four hundred and ninety-four and one half feet deep, and is a dry hole. It is somewhat remarkable that this well, which is almost in the same straight line with the very productive wells Nos. 7 and 8, and just about half way between them, and much deeper than either of them, is nevertheless a dry hole.

No. 12 is a new well just finished, and is not yet (July twenty-ninth), producing any oil. It is four hundred and forty feet deep, and they did not get the water shut off.

No. 13 is four hundred and twenty-five feet west of No. 7; is still drilling, and now down (July twenty-ninth), five hundred feet. The water is shut off at one hundred and fifty-five feet, with eight and five eighths inches casing.

About one thousand eight hundred feet northwesterly from No. 1, and some four hundred or five hundred feet higher up on the flank of Sulphur Mountain, there is another well, drilled by Benj. W. Feldt, in 1879, to the depth of one hundred and eighty-one feet. This well now produces about five or six barrels per day of oil of about 27° B. Mr. Feldt tells me that it first started out with a production of forty-two barrels per day, which it continued for three months or more, after which it gradually fell off during a year or more till it finally reached its present production, which it has since maintained. It is a curious fact that the oil from this well,

heavy as it is, is nevertheless of a light *apple-green* color. It is the lightest colored oil yet seen anywhere in Southern California. Most of the green oils are dark in color, rarely lighter than olive-green, and ranging from that through still darker shades of green and brown to black.

At Well No. 1, in Adams Cañon, the barometer read one thousand and thirty feet.

Along the belt where most of the wells in this cañon are located, the rocks are very rarely visible. But at one point in the gulch just below the largest asphaltum bed, sandstones and shales can be found, which strike northeast and dip northwest.

All along the southern flank of Sulphur Mountain, however, the rocks, consisting of alternating sandstones and shales, with occasionally some coarser grits intercalated, are well exposed, and around the head of Adams Cañon they strike about northeast, and dip about 70° to the northwest. They are here much less broken and distorted than is usual in the oil regions of California. A mile south of here, however, the rocks show again, and there the dip is southeasterly, and still further south for some five or six miles, all the way to the mouth of the cañon, it continues to be so. There is, therefore, a sharp anticlinal somewhere in this region, and the oil wells are mostly on the northwest side of it; while it seems not improbable that the chief beds of asphaltum and tar springs may be very nearly along the line of its axis; though the exposures are not sufficient to determine this with certainty.

Mr. Harvey Hardison states that the general average cost of drilling all the wells hitherto in Adams Cañon, has been about $10 per foot.

The following is a tabular résumé of the wells in Adams Cañon up to July 29, 1887:

Name of Well.	When Drilled.	Depth in Feet.	Product in Barrels per day.
No. 1	1875, or earlier	180	0
No. 2		200	0
No. 3	1885	200	10
No. 4		500	3
No. 5		850	0
No. 6		200	3
No. 7	April, 1886	390	50
No. 8, or "Wild Bill"	June, 1886	735	125
No. 9	July and August, 1886	1,261	0
No. 10		625	0
No. 11	April, May, and June, 1887	1,494½	0
No. 12	July, 1887	440	0
No. 13 (still drilling)	July, 1887	500	
Green Oil Well	1879, or earlier	181	6
			197

Under date of September 26, 1887, Mr. W. L. Hardison furnishes the following additional information:

No. 12 has now been pumped a little, but not much. On the first pumping it yielded thirty barrels.

No. 13 went down about six hundred and fifty feet, and then began producing about August tenth, at the rate of one hundred and seventy-five barrels per day, and is now pumping about one hundred and fifty barrels per day.

No. 14 has been drilled three hundred feet deep; about two hundred feet north of No. 1; was finished about August twenty-fifth, and is said to be pumping about fifty barrels per day.

No. 15 has also been started about five hundred feet northeast of No. 14; is now down about three hundred feet, and is still drilling.

SALTMARSH CAÑON.

This cañon, named after John Saltmarsh, is a branch of Adams Cañon coming in from the west. It has some oil in it, but is not now producing. At the head of the cañon there is some natural seepage, and here also is a tunnel said to be five hundred feet long, which is closed up and inaccessible now, but from which a little oil and water flows. There is not, however, enough of the oil to be of any value. Next west of Saltmarsh Cañon, comes the

WHEELER CAÑON.

The asphaltum deposits and seepages of maltha all around the head of Wheeler Cañon are numerous and extensive. The rocks here all strike nearly east and west, and dip to the north. Some of them consist of exceedingly fine-grained and thin-bedded sandy shales, which split almost like roofing slate.

Three wells have been sunk to various depths in this cañon; but none of them are now producing anything. No. 1 is high up on the southern flank of Sulphur Mountain. It was drilled in January, 1887, and is five hundred and fifteen feet deep. They had water with some oil in it all the way down; but did not get the water shut off, and the quantity of oil was small.

The other two wells are farther down the cañon, and no details were gathered concerning them.

An old tunnel driven into the flank of Sulphur Mountain, about on a level with the mouth of Well No. 1, furnishes a stream of, perhaps, one miner's inch of water, which is saturated with sulphuretted hydrogen, and contains a little oil, but nothing of any value. A little higher up the mountain, another old tunnel is five hundred and seventy-five feet long, and produces nothing.

Lower down the cañon they are now driving another tunnel which will tap Well No. 1 at a depth of two hundred and fifty feet, and will be about six hundred and fifty feet long. It was on July twenty-sixth about three hundred feet long, and was then producing about twelve barrels of oil per day. But Mr. Hardison states, on September twenty-sixth, that it is now in about five hundred feet, and is producing sixty barrels per day. There is also a tunnel in West Wheeler Cañon about three hundred and fifty feet long, yielding about four barrels per day of light green oil.

Six or seven miles west of Wheeler Cañon is Sulphur Cañon, a branch of the Cañada Larga, which latter stream runs westerly to the San Buenaventura River. Following up Sulphur Cañon a distance of some three or four miles from its mouth, we find near the head of the cañon some asphaltum with seepages of dark green oil. A tunnel was driven here forty-seven feet long. A tank was also built and a little oil saved, but not much. In the immediate vicinity of this asphaltum bed there are very extensive deposits of calcareous tufa, and at one locality in the tufa there is a considerable body of impure native sulphur, which was mined to some extent a number of years ago, though not with profit. Several strong sulphur springs also still exist here. The locality is about twelve miles by wagon road from the city of San Buenaventura, and is about one thousand two hundred feet above the sea. The sandstones and shales here

strike northeasterly and dip northwesterly, but they are in some places much disturbed.

One or two miles west from here is Coche Cañon, also a branch of the Cañada Larga, in which three wells have been drilled for oil. The upper one is nine hundred and eighty feet deep, and produced nothing but a small quantity of sulphur water, which still flows from it.

The next well is one hundred and twenty-five feet deep, and furnishes some oil of good quality mixed with a large quantity of sulphur water which flows.

The third well is something over two hundred feet deep, and is tapped at a depth of about forty feet by a tunnel two hundred and fifty feet long, from which a little oil mixed with a good deal of sulphur water flows. Some horizontal holes, from forty to sixty feet long, have also been drilled in this cañon without much result. The present total product of the cañon is about two barrels per day of a dark colored and rather heavy lubricating oil. The barometer at the highest well here read one thousand two hundred and fifty feet. At the tank, it read nine hundred and sixty feet. The rocks here generally strike about N. 25° or 30° E., and stand nearly vertical, though in places they are much crushed and broken. Many of the shales are exceedingly thin-bedded.

Coyote Cañon, a branch of the San Buenaventura River, drains the Lower Ojai Valley, and the locality called "Pinafore" is in a little cañon coming in on the left of Coyote Cañon, *i. e.*, from the southeast, out of the west end of Sulphur Mountain. A well was once drilled here, but it is for all practical purposes a dry hole, though it even yet flows a very little water mixed with a very little oil and gas. Two tunnels were also driven here; one two hundred and twenty-five feet long, and the other one hundred and seventy-five feet long. From the latter a can of thick, viscid, dark green maltha was obtained. The quantity of it visible here, however, is very small. There is a large area of asphaltum and considerable surface seepage here. It is asserted that this well, as well as some others of the older ones now dry on the Ojai Ranch, would have paid, but that they were maliciously plugged up and destroyed in the course of the fights and contests which have taken place in years gone by about these oil lands.

From the Santa Paula Cañon on the east to the San Buenaventura River on the west, Sulphur Mountain (which is well named on account of the numerous sulphur springs on all sides of it) is some twelve or thirteen miles long. As already stated, its highest crests are about two thousand feet above the sea. Immediately north of Sulphur Mountain, and between it and the San Rafael Range of mountains, lies the Ojai Valley, whose length is about coextensive with that of Sulphur Mountain. The Ojai Valley is divided near the middle of its length into two portions, the westerly part being called the "Lower Ojai Valley," and the easterly part the "Upper Ojai Valley," for the very good reason that there is between these two different parts of the valley a difference of from two hundred to four hundred feet in altitude above the sea. The Upper Ojai Valley is drained towards the east by Sisar Creek, which flows easterly to Santa Paula Cañon; while the Lower Ojai is drained by Coyote Creek, which flows westerly to the San Buenaventura River.

It was stated by different parties that only one deep well has ever been drilled on the *top of Sulphur Mountain.* According to Mr. B. W. Feldt, this well, which was not visited by us, is one fourth to one third of a mile westerly from the Coche Cañon wells; while, according to Mr. W. L. Hardison, it is directly north from the "Green Oil Well" in Adams Cañon—a difference of localities of some eight or ten miles.

Wherever this well may be, it was, so far as oil is concerned, a dry hole. Mr. Feldt states that it was one thousand six hundred feet deep, and cost some $50,000. They struck water at one hundred and twenty-four feet, and pumped for awhile between two hundred and three hundred barrels per day of sulphur water. The well was called the "Rotten Egg Well."

On the extreme eastern end of the Ojai Ranch, north of the east end of Sulphur Mountain, and in the right hand edge of the bed of Sisar Creek, there is one of the prettiest cold sulphur springs that the writer ever saw, flowing some two or three miner's inches of beautiful water.

About a mile farther up Sisar Creek, and on the north side of the Upper Ojai Valley, is located a group of oil wells called collectively, "Ojai, No. 6." There are here now five or six old wells pumping an aggregate of some eight or nine barrels per day of a very dark, greenish-brown oil, which is piped to the Mission Transfer Company, at Santa Paula.

These wells are in the midst of extensive asphaltum deposits and tar springs. Their depth varies from one hundred and twenty-five to something over five hundred feet. But there is one dry hole here about one thousand two hundred feet deep.

The Adams Cañon wells are two or three miles over the east end of Sulphur Mountain, a little east of south from here.

The rocks at this locality, where visible, consist chiefly of very heavy-bedded sandstones, and dip to the north. But they are not well exposed.

There are two tanks here which hold two hundred and fifty barrels each.

The northern slope of Sulphur Mountain is heavily timbered with oak.

It must be remembered that this group of wells—"Ojai, No. 6"—is on the *north* side of the valley, near its eastern end, where it is probably not over half a mile wide, though further west it increases to several miles in width.

But a short distance (less than a quarter of a mile) west of "Ojai, No. 6," the belt of asphaltum deposits and tar springs seems to cross the valley, and appear again on its south side, *i. e.*, in the northern foothills of Sulphur Mountain. From here west, all along the northern flanks of Sulphur Mountain, and on the south side of the Ojai Valley, to the San Buenaventura River, tar springs are very numerous, and the areas and depths of the surface asphaltum deposits aggregate something enormous. It is doubtful if there is anything of its kind equal to it in magnitude anywhere else in the State.

There have been probably six or eight wells, some of them deep ones, sunk within the last twenty-two years, along the southern edge of the Ojai Valley. But none of them are producing anything now. Why not, I could not learn, beyond the statement that some of them had been plugged up.

At "Ojai, No. 6," the rocks, so far as exposed, dip to the north.

The last well drilled on the Ojai Ranch was sunk in Gibson's field, near the spring, in September, 1886, three hundred and fourteen feet deep. They went through soft material only, except that at the depth of two hundred feet they struck a "tar bed" fifty feet thick. The well gave nothing but a small flow of water.

The barometer (aneroid) at the group of No. 6, Ojai wells, read one thousand one hundred and forty feet; at Mr. Hobart's place one thousand one hundred and thirty feet; at Mr. Gibson's place, one thousand two hundred and sixty feet. All these places are in the "Upper Ojai Valley." But a short distance northwest of Mr. Hobart's place there is a steep descent of several hundred feet into the "Lower Ojai Valley," in which, further west, is the town of "Nordhoff."

At Mr. Gally's place, in the Lower Ojai, about one mile east of Nordhoff, the barometer read eight hundred and thirty feet. On the north side of the Ojai Valley, in the San Rafael Mountains, the exposures are good, and the strata generally dip to the north. On the south side of the valley, however, the exposures are few and poor.

It is true that the farmers occasionally lose cattle in these asphaltum beds. The cattle lost, however, are not drowned in liquid petroleum; but get stuck fast in the thick, strong tar, and, being unable to pull themselves out, stay there till they starve to death.

All the oil now obtained in Ventura County is handled by the "Mission Transfer Company," of which Mr. F. E. Davis, of Santa Paula, is President.

The wells in Santa Paula, Adams, and Wheeler Cañons are owned by the "Hardison & Stewart Oil Company." Those in Pico Cañon are owned by the "Pacific Coast Oil Company."

A two-inch pipe line was once laid from Pico Cañon to Santa Paula, but it is now disconnected and disused. Barometer at Santa Paula read two hundred and sixty-five feet.

The oil from the Sespe, Santa Paula, Adams, and Wheeler Cañons, and the Ojai Ranch, is piped directly by the Mission Transfer Company to their large storage tank at Santa Paula. This tank, built by G. J. O'Brien, of Finley, Ohio, was called by him a thirty-five thousand barrel tank; but the oil men here call it a thirty-two thousand barrel tank. Its dimensions, however, are stated to be ninety-three feet diameter, and twenty-four feet seven inches high, which give for its maximum capacity twenty-nine thousand seven hundred and forty-three barrels of forty-two United States standard gallons each. The pipes leading from the wells to this tank are two-inch pipes, and there are altogether about seventy miles of them. From this tank a four-inch pipe runs a distance of eighteen miles to another tank of the same size, recently finished at Hueneme, whence most of the Ventura County oil is shipped by sea to its various destinations. From the Hueneme tank to the landing, a distance of about one mile, there is a six-inch pipe.

The cost of the tank at Santa Paula is stated to have been $7,400. The one at Hueneme cost a little more, probably about $7,700. Both these tanks, however, were purchased in the East at second hand. A new seven thousand barrel tank has been contracted for in San Francisco at $5,200.

Two-inch pipe line here costs about 25 cents per foot *laid in place*. Tank cars holding about one hundred and thirty barrels each cost, delivered in Los Angeles or Ventura Counties, about $1,000 each.

There is a small tank, holding about three thousand barrels, at San Buenaventura. There is here also a so called "refinery," owned by the "Paraffine Paint Company" of San Francisco, which handles a certain quantity of the Ventura County oil. The only "refining" which they do, however, consists of a simple distillation at a temperature of about 600° F. (a little less than the melting point of lead), the distillate being returned to the tanks of the Mission Transfer Company, while the black residue, which, when cold, is brittle, but when somewhat warm is tough and elastic, though not sticky unless the temperature is pretty high, is shipped to San Francisco, where it is used in the manufacture of paint and for some other purposes.

The following statement of the quantity of oil handled by the Mission Transfer Company during a period of thirteen months was furnished from the books of the company by Mr. Manning, the Secretary, in barrels of forty-two gallons each:

Month.	From Adams Cañon.	From Wheeler Cañon.	From Scott Wells, Santa Paula Cañon.	From Ojai Ranch.	From Sespe Region.	Distillate.	Total.
1886—June	2,562.38	320.62	331.38	373.69	....	218.86	3,806.93
July	5,102.55	312.86	178.83	201.40	....	134.12	5,929.76
August	4,018.45	302.00	232.14	....	....	501.55	5,054.14
September	4,172.87	143.66	165.82	....	....	156.32	4,638.67
October	4,375.73	588.26	194.63	56.12	....	792.04	6,006.78
November	3,406.43	468.02	220.88	66.31	....	441.80	4,603.44
December	2,855.10	171.70	178.84	50.00	....	581.23	3,836.87
1887—January	3,215.69	319.76	176.21	....	....	581.21	4,292.87
February	3,287.47	474.14	52.60	....	....	347.14	4,161.35
March	5,004.47	327.09	228.52	27.97	....	....	5,588.05
April	2,988.51	332.32	268.19	....	....	....	3,589.02
May	3,707.06	340.90	261.74	....	....	....	4,309.70
June	4,229.27	480.63	273.22	....	5,514.29	....	10,497.41
Totals	48,925.98	4,581.96	2,763.00	775.49	5,514.29	3,754.27	66,314.99

In order to obtain from this table the actual quantity of crude petroleum produced, the 3,754.27 barrels of distillate, which were returned to the tanks from the refinery at San Buenaventura, must be deducted from the total as given. Bearing this in mind, we find the average daily product for the year from June 1, 1886, to June 1, 1887, to have been as follows:

From Adams Cañon	122.46 barrels.
From Wheeler Cañon	11.24 barrels.
From Santa Paula (Scott Wells)	6.82 barrels.
From Ojai Ranch	2.12 barrels.
Total	142.64 barrels.

But a portion of the 5,514.29 barrels credited to the Sespe region for the month of June, 1887, is really due to the previous months of February, March, April, and May, since the Sespe Well, No. 1, finished drilling on February twelfth, and No. 2 was drilled in April.

The average gravity of the oils from various cañons is stated to be as follows: From Adams Cañon, 26° to 27° B.; from Santa Paula Cañon, 23° B.; from Ojai Ranch, 19° to 20° B.; from Sespe region, 31° B.

Dr. S. P. Guiberson, of Santa Paula, states that infusorial siliceous rock occurs in large quantities throughout Township 3 N., of Ranges 19, 20, and 21 W., S. B. M., in the San Fernando Range of mountains, and that the rocks there dip 40° to 45° towards the south. He also exhibited a piece of obsidian, which, he said, came from the same range of mountains, about four miles southeast of Santa Paula.

Mount San Cayatana, five miles northeast of Santa Paula, in T. 4. N., R. 21 W., S. B. M., is said to be near five thousand feet high. Mount Topotopo, north of Santa Paula, and northeast of the Adams Cañon wells, in T. 5 N., R. 21 W., S. B. M., is somewhat higher, and Hines' Peak, to the north of Topotopo, is said to be over six thousand feet high.

The following letter, from the Hardison & Stewart Oil Company, is self-explanatory:

"Santa Paula, Cal., November 29, 1887.

"W. A. Goodyear, *Geologist*, *San Francisco*, *Cal.*:

"Dear Sir: Your favor of the twenty-third instant at hand.

"Adams, No. 15, is located six hundred feet east and two hundred feet north of No. 14. Abandoned October twenty-fifth, was drilled one thousand feet deep and dry. No. 16 is located about four hundred feet west of No. 8, and is flowing one hundred barrels per day. Completed November twenty-sixth.

"Saltmarsh, No. 1, is located about a mile west of Adams, No. 16, and is flowing about two hundred barrels per day. Completed November fifteenth.

"The Tunnel was completed at six hundred and fifty feet and the increase in oil did not more than keep up the decline while finishing, was completed November tenth.

"Sespe, No. 6, is situated a little south of east of No. 1, was drilled nine hundred feet deep and dry, finished October twenty-eighth.

"Sespe, No. 7, is located about eight hundred feet northwest of No. 5, nearly east of No. 2, about one thousand two hundred feet distant; is pumping about seventy-five barrels per day, is three hundred and seventy-five feet deep, and finished October fifteenth.

"No. 8 is located about one thousand eight hundred feet northwest of No. 4, and is pumping one hundred and fifty barrels, is three hundred and seventy feet deep, and finished November second.

"No. 9 is located between No.'s 1 and 4, about four hundred feet from No. 4, and pumping seventy-five barrels, drilled three hundred and forty feet. Completed November twelfth.

"No. 10 is located about four hundred feet south of No. 7, and is drilling at two hundred feet, and showing for a seventy-five barrel well.

"No. 11's rig is up ready for drilling, is located between No.'s 4 and 8, and one thousand four hundred feet northwest of No. 1.

"Yours very truly,

"HARDISON & STEWART OIL COMPANY.

"By W. P. Stewart."

A telegram received from Mr. Hardison just as this report is going to press, and dated December 20, 1887, states that in Adams Cañon, well No. 16 is now seven hundred and twenty feet deep; that it struck oil on the ninth instant, sent the oil seventy feet into the air, and has *flowed eight hundred barrels per day.*

Miscellaneous Remarks.

The total cost of the outfit, *i. e.*, derrick, engine, boiler, and all tools, etc., required for drilling a well in California, is stated at about $3,000.

It then usually requires four men to drill the well, *i. e.*, one professional driller, at $4, and one helper, at $2 50, for each shift (or "tour" as it is called) of twelve hours per day, running day and night.

They now generally start the drilling with a twelve-inch bit, and finish with a five-inch bit.

The casing most employed is lap-welded, and screwed together; though at some wells sheet-iron casing is used.

The total cost of drilling a well, reckoned per foot, will of course depend greatly upon its depth. But in California, it will depend perhaps even more upon the character and position of the rocks drilled through. In the East the oil rocks lie nearly horizontal, and extensive experience has developed much valuable information concerning the character of the rocks which must be drilled through in a given oil region. Here it is not so. The rocks are generally greatly crushed, and broken, and upturned at various angles, and no man knows beforehand what he may strike at a moment's notice. It is difficult drilling in such rocks, which dip anywhere from 30° to 85°, and where you may at any moment strike a hard stratum which will throw your drill aside and give you a crooked hole, or else lose your tools and have no end of fishing; or where you may strike quicksand, or many other troubles. These are the reasons why it costs so much more

to drill for oil in California than it does in Pennsylvania. The average ratio is probably about three to one.

As to what it may cost to sink a well to any given depth in any part of California, no man can tell beforehand. If you are favorably situated and lucky, you may, perhaps, get a well one thousand five hundred feet deep at a cost of $5 or $6 per foot. If you are unlucky, it may cost you $40 or $50 per foot or more, and you may have a dry hole at last. But the general average cost for many wells for some years past has been somewhere in the neighborhood of $10 per foot.

On one point the writer can not entirely agree with Professor S. F. Peckham, whose extremely valuable report on "The Bituminous Substances Occurring in Southern California," was published in "The Geology of California, Vol. II, Coast Ranges, Appendix," by J. D. Whitney, 1882. Professor Peckham there makes the following statement, page 50:

"The source of the bitumen is invariably found to be a bluish slate or shale, more or less firmly indurated, and containing a variable proportion of fine quartzose sand. This rock when mined and suddenly exposed to atmospheric influence, in the majority of instances, rapidly disintegrates, and becomes, when wet, a mixture of plastic clay and sand. It also contains more or less protoxide of iron, which causes it to weather of all shades, from dirty white to brown, and, when metamorphosed by heat, to assume, by peroxidation of the iron, all the shades of ochre and brick red. Bitumen is sometimes seen issuing from crevices in sandstone, but, in such instances, underlying or overlying strata of argillaceous rocks are invariably its original source. Bitumen is not always found where rocks possessing these mineralogical characters are exposed, but the presence of bitumen invariably indicates such rocks as its source. Sandstone, *per se*, is, in no instance that has come under my observation, an indication of the proximity of bitumen."

I have quoted the whole of the foregoing paragraph, in order that I may do its eminent author no injustice. I comment as follows: his description of the character of the "bluish slate or shale," which occurs in such large quantities in the oil regions, is very full and accurate.

But the many deep wells which have been drilled in Southern California since that report was written (1866), have demonstrated the fact that, as a general rule, the oil is found to exist there, *not in the shales*, *but in the sandstones*. To such an extent is this true, that we find one experienced well driller at Moody's Gulch, Santa Clara County (see above), talking of "first," "second," "stray," and "third sands," just as he would in Pennsylvania, though the Pennsylvania oils are Devonian, and the California oils are Tertiary, and there is room for no sort of comparison between the two localities. And it is just as true throughout Los Angeles and Ventura Counties, that the oil has been chiefly found in *sandstone*, as it is at Moody's Gulch. This being the case, I can see no good reason for assuming (for it is nothing more than assumption) that the oil always *originated* in the clay shales.

Sandstone, however, *per se*, is, of course, in no case, any indication of the proximity of bitumen.

Another item of interest, however, is this: sulphur water or sulphur springs, warm or cold, are, in no instance, indications of the proximity of bitumen. But, *vice versa*, the presence of bitumen *is* a strong indication of the probable proximity of sulphur springs. There are many sulphur springs scattered through the length and breadth of the "Coast Range," where there are no indications of hydrocarbons. But, so far as my observation goes, wherever petroleum or asphaltum is found, there sulphur will be found, in some shape close at hand.

COAL.

COAL.

In 1877 Mr. W. A. Goodyear published an exhaustive report entitled "The Coal Mines of the Western Coast of the United States." Up to the time of its publication it was the most complete report of the coast on the subject.

The author has given permission for the use of that portion relating especially to the State of California, and has made additions and corrections to make the work complete to date.

Preface.

In writing this little book, the object which I have had in view has been not so much to discuss the geological character of the Pacific Coast coal fields, as to give, what has never yet been published, a full and intelligible description of the mines themselves as they exist to-day. To what extent I have succeeded in accomplishing this, the reader must judge.

I regret that my acquaintance with the mines of British Columbia, which are for the most part confined to Vancouver Island, is not sufficient to justify me in attempting to give any particular account of them. I have, therefore, excluded them from this work, although they are of no little importance, and are rapidly increasing their annual production.

The volume, in its present form, is mainly the result of my own work, travels, and observations, extending over a period of nine or ten years, during which period it is safe to say I have done more work in, and have been personally more familiar with the actual condition and workings of, the various coal mines of the Pacific Coast than any other engineer has done.

In addition to this, however, I am also greatly indebted, as the text will show, to the labors of my friend and former partner, Mr. Theodore A. Blake, M.E., who is even more intimately acquainted with the mines of Washington Territory than I have been myself, and whose early investigations of the Seattle coal field, in particular, were exceedingly thorough and valuable. I desire, furthermore, to express my obligations especially to Mr. P. B. Cornwall, President of the Black Diamond Coal Company; and, in general, to the officers and Superintendents of the other coal companies throughout the country, for the liberality with which they have not only furnished all such information as I have directly asked from them, but also freely placed at my disposal every other facility for acquiring a full and thorough knowledge of their respective mines.

W. A. GOODYEAR.

San Francisco, March, 1877.

Chapter I.—California.

The coal fields of the western coast of North America are limited in extent, and of comparatively recent geological origin. They are none of them of the Carboniferous Age, and, indeed, so far as yet known, none of them date back of the Cretaceous Period. They mostly furnish a non-

caking, bituminous coal, which belongs to the class of lignites, or brown coals. Vancouver Island, however, produces caking coal, and some caking coal of good quality has also been found in Washington Territory. Small quantities of anthracite have been found on Queen Charlotte's Island, and probably also in Washington Territory. But no workable mine of anthracite has ever been discovered on the coast, and the little that has been found has always proved, on investigation, to have been the result of local and special metamorphism. Of the two States and one Territory which border the Pacific Ocean between Mexico and British Columbia, Washington Territory is by far the most liberally supplied with coal. Oregon comes next, and California last. In fact, California is decidedly unfortunate in the extent and the character of her coal fields. For, although it is easy to find coal at many localities in the Coast Range, from one end of the State to the other, as well as at certain points in the western foothills of the Sierra Nevada, yet it generally happens that its quality is poor, or its quantity is small, or else that it is situated in the heart of the mountains, so far from market that the cost of transportation alone would far exceed the value of the coal.

I begin this treatise, however, without further prelude, by giving a description of the only field within the State where coal has hitherto been profitably mined, viz.:

THE MOUNT DIABLO COAL FIELD.

The extent of the Mount Diablo coal field may be stated in broad terms to be some ten or twelve miles along the line of outcrop of the beds running through the northern part of T. 1 N., R. 1 E., and the northwestern and central portions of T. 1 N., R. 2 E., M. D. M.

The details of this line of outcrop are, in many places, very irregular, and especially so in the western portion of the field, where the hills are high, and the cañons are deep and steep. But its general course may be described as follows: It is curvilinear, and convex towards the north. Beginning in the northeast quarter of Section 7, T. 1 N., R. 1 E., it runs at first northeasterly, but curves rapidly to the east till it reaches a point in the northwest quarter of Section 8, from whence it follows for almost three miles a nearly true east course across the northern portions of Sections 8, 9, and 10, and close to the northern edges of these sections. But in going easterly across Section 11, it bends to the south, and crossing the south half of Section 12, enters the southwest quarter of Section 7 in the adjoining township. From thence it follows an irregular southeasterly course across the northwestern and central portions of the township as far as the "Brentwood Mines," upon the Rancho de Los Meganos, and near the line between Sections 22 and 27 of T. 1 N., R. 2 E. Beyond this locality, to the southeast, the beds have not been traced with any certainty. The dip, throughout, is in a northerly direction; but it varies in amount at different localities from 12° or 15° up to 32° or 33°, being generally highest in the western portion of the field.

A range of high hills, whose culminating points on Sections 8 and 9 reach altitudes of fifteen hundred to seventeen hundred feet above the sea, runs in a general east and west direction across the northern half of T. 1 N., R. 1 E., and is separated by a narrow valley on the south side from the still higher mountainous region which culminates in the double summit of Mount Diablo itself, three thousand eight hundred and fifty-six feet in height.

In going east, however, from Section 9, the hills diminish in height, and

following the line of the coal beds southeasterly across the next township, they gradually fall lower and lower, till we reach the level of the valley at the "Brentwood Mines," which are situated in the edge of the San Joaquin plain, at an altitude of only between one hundred and two hundred feet above tidewater. In its higher portions, this range of hills is deeply scored by cañons in all directions, and it is among these cañons in the northern slopes of the range, that the hitherto paying mines are located.

The strata have been considerably disturbed at numerous localities by faults of greater or less magnitude; and the coal beds themselves are subject, within short distances, to so great variations in thickness and quality of coal, as well as in the character of the rocks which inclose them, that it is not possible with present knowledge to certainly recognize any single bed in the eastern portion of the field as being the same with any one of those which have been so extensively worked in the western portion.

By the phrase, "Mt. Diablo coal field," as here used, must be understood not merely the actually productive region, but the whole extent of the belt through which there has been found some definite evidence of probability that the beds were once continuous, or nearly so, and within which sufficient discoveries have been made to lead to the expenditure of any considerable sums of money in explorations and attempts to develop new mines. The area within which the mines have hitherto been profitably worked, however, is far more limited in extent. It lies among the higher hills in the western portion of the belt above described, and includes a distance of only about two miles and a half along the strike of the beds, from the western limits of the Black Diamond Company's workings in the northeast quarter of Section 7, where the beds either split up and run out, or become too much crushed and broken to pay for working, to the most eastern limits of the Pittsburg Company's workings in the southwest quarter of Section 3, and the northwest quarter of Section 10, where they are stopped by the wall of a great fault which intervenes between them and Stewart's mine on the east.

The "Central (*i. e.*, Stewart's) Mine" is not here included within the profitably productive limits, for the simple reason that while it has produced considerable coal (its shipments having been sometimes as high as a thousand tons per month), it is more than probable that its production has been at a loss, instead of a profit, to its owners.

Within the productive limits above indicated, the chief openings of the mines, as well as the dwellings of the miners, and other buildings, are, owing to the topography of the country, concentrated at two considerable villages, about a mile apart. The first of these villages, known as "Nortonville," is located on the southeast quarter of Section 5. The second one, known as "Somersville," is chiefly on the southeast quarter of Section 4, T. 1 N., R. 1 E. Each village is in the bottom of a sort of amphitheater among the hills, and at the head of a deep cañon, which runs northerly some three miles to the edge of the San Joaquin plain, from which point the distance north across the plain to the river is also in each case about three miles. Down each of these cañons there runs a railroad of the ordinary gauge (four feet eight and one half inches), to points of shipment on the San Joaquin River, just above its junction with the Sacramento. Each railroad is, therefore, about six miles in length, the Black Diamond Railroad running to the Black Diamond Landing (otherwise known as New York Landing), and the railroad from Somersville (called the "Pittsburg Railroad") running to Pittsburg Landing, some two or three miles further up the river. The height of the villages themselves above tidewater ranges from seven hundred to eight hundred and fifty feet.

In the northwest corner of the southeast quarter of Section 5, a round-topped hill rises to a height of one thousand three hundred and forty-eight feet above low water, and near the middle of the line between the northwest and southwest quarters of Section 4, a similar hill rises to a height of about one thousand five hundred feet. Each of these two hills (between which runs the cañon of the Black Diamond Railroad) is connected with the hills to the south, in which lie the mines, by a saddle some three hundred or four hundred feet lower than its own summit—the saddle between Nortonville and Somersville being some three or four hundred feet higher than the village of Nortonville itself.

There are few points in the hills containing the mines which rise to a greater height than the higher of the two hills just described. At Nortonville, as well as at Somersville, the cañon at the head of which stands the village forks into numerous branches which spread upwards in all directions to the south, southeast, and southwest, among the hills, thus cutting up the surface of the mining ground by rough and precipitous gulches, often two hundred to three hundred feet in depth, so that the line of outcrop of the beds, as already stated, is at this locality very irregular in detail and deeply indented by the gulches. The rocks which inclose the mines consist of unaltered grayish and reddish silicious sandstone, generally not very hard, alternating with occasional strata of rather soft clayrock, the whole belonging to the latest formations of the cretaceous period.

The coal beds, which have been profitably worked to a greater or less extent, are three in number, and are known respectively as the "Clark Vein," the "Little Vein," and the "Black Diamond Vein." Of these, the Clark Vein is the highest in stratigraphical position; next in order below it comes the Little Vein; while the Black Diamond Vein is the lowest, and underlies both the others. The beds lie nearly parallel with each other, all dipping to the north; and at the immediate localities of the villages, both of Nortonville and Somersville, the amount of dip is from 30° to 32°.

In the Clayton Tunnel, at Nortonville, the level distance from the floor of the Clark Vein south to the roof of the Black Diamond Vein is six hundred and ninety-six feet; the dip here being about 31°, it follows that the total thickness of the strata, including the Little Vein, between the Clark and Black Diamond Veins is, at this locality, about three hundred and fifty-nine feet. At certain points the level distance between the beds is somewhat less than it is here, while in other places it is considerably greater. This is due mainly to changes in the degree of dip of the beds; though it is more than probable that the actual thickness of the strata between them also varies somewhat at different localities.

All the valuable mining ground here for a distance of nearly two miles and a half is now owned and controlled by three different companies, viz.: the Black Diamond Coal Company, the Union Coal Company, and the Pittsburg Coal Company. The Black Diamond Company owns the south half of Section 5, the north half of Section 8, and the northwest quarter of Section 9. The Union Company owns the southwest quarter of Section 4, and used to lease and mine the coal also in an adjoining strip to the east, between six hundred and seven hundred feet wide, on the southeast quarter of Section 4. The Pittsburg Company owns the balance of the southeast quarter of Section 4, together with an additional tract which covers portions of the northeast quarter of Section 9, the northwest quarter of Section 10, and the southwest quarter of Section 3.

The Clark Vein.

The only bed which has been worked continuously throughout the whole distance controlled by these companies is the Clark Vein. This bed varies in thickness at different points from a minimum of eighteen or twenty inches to a maximum of four feet and a half, or a trifle over. The greatest variations in the thickness of this bed, however, do not occur within the limits of the Black Diamond Company's property, the minimum thickness in that property being twenty-eight or twenty-nine inches, and the maximum thirty-eight or thirty-nine; while the average for the whole mile of the Clark Vein controlled by this company, and as deep as the workings have yet extended, is thirty-two or thirty-three inches. On going east from the section line, however, into the southwest quarter of Section 4, the bed grows rapidly thinner, and for a considerable distance in the western portion of the Union Company's ground its thickness ranges under twenty-four inches, being sometimes as low as eighteen. But in the eastern portion of the Union Mine it again increases in thickness, and maintains across the southeast quarter of Section 4 a thickness of from three to four feet, reaching its maximum in the Pittsburg Company's ground not far from the line between Sections 3 and 4, where, as already stated, it is sometimes a little over four and a half feet thick. The Clark Vein is generally free from interstratification of slate or dirt of any kind, and with the exception of a certain portion in the western part of the Black Diamond Company's mines near the southwest corner of Section 5, where, for several hundred feet it has been rather badly crushed by movements and bendings of the strata, the whole of it makes good, clean coal. Its roof and floor are also generally very good, so that it requires but little timbering. The floor is everywhere good solid sandstone, and the roof throughout the Black Diamond Company's mines, and in the western portion of the Union Company's ground, with few and small exceptions, consists also of the same material. But where the coal begins to increase in thickness in the eastern part of the Union Mine, a thin stratum of rather soft clay rock makes its appearance on top of the coal and between it and the overlying sandstone. Further east, this clay stratum is nearly continuous, forming, generally, the immediate roof of the coal throughout the Pittsburg Company's ground, and seeming, as a rule, to be thickest where the coal is thickest. It reaches, in places, a maximum thickness of from two to two and a half feet, and as it separates easily from the overlying sandstone, it causes, of course, some extra trouble and expense, and occasionally more or less danger in mining the coal. But it is nothing very serious.

The chief openings to the Clark Vein are, first, the Black Diamond Company's openings, which are three. Of these the first is what is known as the "Little Slope," or the "Hoisting Slope;" the second is the "Mount Hope Slope," and the third is the Black Diamond Shaft. Second, the Union Company's Slope. Third, the slope of the old "Eureka Company," which formerly owned a tract about eleven hundred feet wide immediately adjoining the Union Company on the east, and now belonging to the Pittsburg Company. Fourth, the Pittsburg Slope. Fifth, the "Independent Shaft," situated on ground formerly owned by the old "Independent Company," but now also belonging to the Pittsburg Company.

The mouth of the "Hoisting Slope" of the Black Diamond Company is situated in the bottom of a deep ravine which runs up southerly and southwesterly among the hills, and is eight hundred and thirty-three feet above low water in the San Joaquin River. This slope, which is ninety-eight feet long, goes down to the south with a pitch of about 35° through the strata

overlying the Clark Vein. From its foot, a level gangway, known as the "Clark Vein Main Gangway," has been driven east and west on the Clark Vein throughout the company's property, and is over a mile in length across the southern part of Section 5. The slope is furnished with a double track, and a steam hoisting engine whose cylinder is 14″×30″. Through this slope has been hoisted nearly all the coal which has come from the Clark Vein within the limits of the Black Diamond Company's property above the level of the Clark Vein Main Gangway, besides all the coal which has come from the Black Diamond Vein through the Clayton Tunnel.

The mouth of the "Mount Hope Slope" is situated about four hundred and fifty feet northeasterly from that of the "Hoisting Slope," and is seven hundred and ninety-seven feet above low water. The slope is two hundred and ninety-three feet long to the Clark Vein, and has an inclination, or pitch, of 37° 15′ to the south. From its foot, the "Mount Hope Gangway" runs east and west on the Clark Vein through the property, and is also over a mile in length. The height of the "lift" between the Mount Hope and the Clark Vein Main Gangways (*i. e.*, the slope distance measured on the dip of the coal bed from center to center of these gangways), is in the vicinity of the Mount Hope Slope about three hundred and six feet. But in the western portion of the property the height of this "lift" increases considerably, owing to a decrease in the dip of the bed, the gangways being driven nearly level, or with only so much grade, about one in one hundred, as is necessary in order to drain them, and to facilitate the hauling out of the loaded cars. The Mount Hope Slope is provided with a double track and a hoisting engine, with cylinder 14″×30″. From a point on the Mount Hope Gangway eighty-five feet east of the foot of the Mount Hope Slope, a double tracked counter-slope runs down on the coal with a pitch of about 31° to the north, a distance of three hundred and seventy-seven feet to the "Lower Mount Hope Gangway," which is the lowest gangway yet opened on the Clark Vein by the Black Diamond Company. The coal from this lower gangway, until they began to hoist through the shaft, was hoisted up the counter-slope by an underground hoisting engine 16″×30″, placed at the head of the counter-slope, and supplied with steam from the boilers at the surface by a pipe leading down the Mount Hope Slope.

The Black Diamond Shaft is distant about six hundred and twenty feet in a direction a little north of west from the mouth of the Mount Hope Slope. It is a vertical shaft, heavily and well timbered, and measures twenty-two feet four inches by eleven feet ten inches from out to out, being divided into three compartments, viz.: one pumping compartment five by nine feet, and two hoisting compartments, each six by nine feet in the clear, inside of timbers. The mouth of the shaft is eight hundred and thirty-nine feet above low water, and its present depth to the level of the Lower Mount Hope Gangway is four hundred and fifteen feet, and the foot of the shaft is about fifty feet south of this gangway. The shaft is furnished with two iron, double-decked safety cages, each cage raising two loaded mine cars at a time, and each car containing about a ton of coal. The hoisting power for this shaft consists of a pair of large steam engines working directly on the winding shaft, each engine having a twenty-four-inch cylinder, and five foot stroke. The cables used here are flat wire ropes winding on spools.

The mouth of the Union Company's Slope is situated very close to the line between the southeast and southwest quarters of Section 4, and is eight hundred and sixty-six feet above low water. The slope itself is four

hundred and seventeen feet long to the Clark Vein, with a pitch of 37° 45′ to the south. From its foot a gangway runs east and west on the Clark Vein through this company's property. From a point on this gangway two hundred and forty-four feet west of the foot of this slope, a counter-slope runs down on the bed with a pitch of 28° 23′ to the north, three hundred and four feet to a second gangway, and then about three hundred feet further to the third or lowest gangway in this mine. Each of these slopes was worked by a steam hoisting engine placed at its head, the underground engine at the head of the counter-slope being supplied with steam from boilers at the surface, as in the case of the Mount Hope and its counter-slope.

The old Eureka Slope was about two hundred and ninety feet long, with an average pitch of about 43° 15′ to the south. It was furnished with a three-rail track and a hoisting engine 10″ × 24″. Its mouth is seven hundred and eighty-six feet above low water. There was also a counter-slope fifty-five feet west of the foot of the surface-slope, which went down some six hundred feet or more, and was furnished with a double track and a hoisting engine, 12″ × 24″. The whole of that portion of the Clark Vein originally owned by the Eureka Company has already, however, been worked out and exhausted, and these openings are therefore now abandoned.

The Pittsburg Slope is in the southeast corner of Section 4. Its mouth is eight hundred and thirty-eight feet above low water. It goes down in a direction somewhat to the west of south, with a pitch of 25° 50′, and is about two hundred and forty feet long to the Clark Vein. It is furnished with double track and steam hoisting engine, 12″ × 24″. From its foot a gangway runs both ways on the bed through the company's property. From a point on this gangway twenty-five feet west of the foot of the surface-slope, a counter-slope runs down on the dip about eight hundred feet with a pitch of about 31° 30′ to the lowest gangway in the mine. There are, however, two intermediate gangways, one at a point three hundred feet and the other at a point five hundred and seventy-nine feet down from the head of the counter-slope. The slope is double-tracked and is worked by a steam engine, 14″ × 30″, at its head.

In the eastern part of this mine and distant nearly a quarter of a mile from the foot of the surface-slope, there is another counter-slope running down from the upper gangway to the second one. This slope is also double-tracked and furnished with a hoisting engine. Both the underground engines are furnished with steam through pipes conducting it from the boilers at the mouth of the surface-slope.

The Independent Shaft is a vertical shaft sunk by the now defunct Independent Company about the year 1865, at a point a little southwest of the center of the northeast quarter of the southeast quarter of Section 4. The size of this shaft from out to out is nearly sixteen feet by ten, and it is divided inside the timbers into three compartments, viz.: one pumping compartment, three feet by seven feet eight inches, and two hoisting compartments, each four feet by seven feet eight inches in the clear. Its mouth is seven hundred and nineteen feet above low water, and it is seven hundred and ten feet deep.

Some curious engineering was displayed in connection with the sinking of this shaft. It was represented, for example, at the time of its commencement, that it would strike the Clark Vein at a depth of from four hundred to four hundred and fifty feet; yet the position of the Clark Vein, and the amount of its dip in this vicinity, were at that time already well known, and a little simple measurement and computation would have dem-

onstrated then as well as now the fact that a vertical shaft to the Clark Vein at that locality, must be in the neighborhood of nine hundred and fifty feet in depth instead of four hundred or four hundred and fifty. However, they went down seven hundred and ten feet, and then getting tired of sinking, left about twenty-four feet in the bottom of the shaft for a sump, and started a level tunnel to the south, at the depth of six hundred and eighty-six feet, for the coal. They drove this tunnel to the Clark Vein, its length proving to be (according to the best accounts afterwards obtainable) about four hundred and twenty feet. When within about one hundred and fifty feet of the coal, they struck a large stream of water, which necessitated heavy pumping machinery, and a steam engine was erected and a Cornish pump put in. But the foundations for the engine were bad, and it was never firm upon its bed. Moreover, the only available water was that from the mine, which was so heavily charged with a mixture of various sulphates, with probably some free sulphuric acid, as to be exceedingly destructive to the boilers. Nevertheless, the Clark Vein was at last reached, and a gangway driven, and a considerable area of coal worked out above its level, stretching upward towards the lower workings of the Eureka Company. But the work was done at a heavy loss, and it was finally abandoned, the parties who inaugurated it becoming bankrupt. It is said that the amount of money expended here before the coal was reached was over $150,000. While the work was in progress a connection was made with the lower Eureka workings by a shoot driven up along the coal for purposes of ventilation. This shoot afterwards answered the purpose of a water-drain for the Eureka Mine; and the Eureka Company, having in the course of time purchased the Independent property, employed the Independent Shaft, at considerable expense, for a year or two, merely as a pumping shaft, in which the water was held at a certain level, which just sufficed to drain the lower workings of their own mine. But after having exhausted the Clark Vein in their own property down to the top of the old Independent workings, the Eureka Company, in its turn, stopped work, and subsequently sold both the Eureka and Independent properties to the Pittsburg Company, which now owns them. The Independent shaft is now abandoned and idle. It will be noticed, however, that the level at which the tunnel from the foot of this shaft struck the Clark Vein is at a considerably greater depth than any other point which has yet been reached in the Mt. Diablo mines.

As a general rule, the coal close to the surface of the ground is not of good quality in any of the beds. The outcrop of the Clark Vein is, in many places, nothing more than a soft clay shale, light brown in color, and very slightly carbonaceous. At a few points there was good coal in the Clark Vein very close to the surface, but the depth at which the coal in this bed first becomes marketable generally ranges from one hundred to two or three hundred feet, measured on the dip of the bed.

The height to which the coal has been worked in the hills up towards the outcrop varies greatly, of course, at different localities, depending on the configuration of the surface, which the ravines have scored so deeply, and at one point depending on another circumstance, viz.: the fact that immediately to the south of the "Little Slope" of the Black Diamond Company, and extending for a considerable distance, both east and west of it, there was an area of several acres in which the coal was entirely wanting, and which presented every appearance of having been, at some time in the past, on fire and burned out. The maximum height, however, to which the coal has been mined on the Clark bed, within the limits of the Black Diamond Company's property above the Clark Vein Main Gangway,

is about six hundred and seventy-five feet, and a fair statement for the *average* height of the workings above this gangway, for the whole distance of a mile across the southern part of Section 5, would be about five hundred feet.

The height of the "lift," also about one mile in length, between the Mount Hope and the Clark Vein Main Gangways, varies from a minimum of three hundred and six feet in the eastern portion of the mine to a maximum of about five hundred in the western portion, owing to a decrease in the dip of the bed going west. Probably a fair average for the height of this lift for the whole mile would be about three hundred and fifty feet. The height of the next lower "lift," and the present lowest one on the Clark Vein, in the Black Diamond Company's mines, *i. e.*, the lift between the Mount Hope and the Lower Mount Hope Gangways, increases going west from three hundred and seventy-seven feet in the eastern part of the mine to about four hundred and fifty in the western part. This "lift" is now only about four thousand three hundred feet long, the Lower Mount Hope Gangway not having been driven so far to the west as the upper gangways have been.

The Clark Vein at the present time (1877) may be said to be practically exhausted throughout the Black Diamond Company's property down to the level of the Lower Mt. Hope Gangway, the quantity of coal which yet remains to be extracted from above that level being very small; but below this gangway it is all untouched and solid.

In the Union Mine they have worked above their Clark Vein Gangway No. 1 (*i. e.*), the gangway at the foot of their surface-slope, for a height of about six hundred feet up to the old Manhattan Gangway. The latter gangway (driven by the old Manhattan Company, which formerly owned the northwest quarter of Section 9 and afterwards sold it to the Black Diamond Company), started on the outcrop of the Clark Vein in the bed of a gulch in the southwest part of the southeast quarter of Section 4, and was driven westerly on the Clark Vein some twenty-four hundred or twenty-five hundred feet, extending for most of this distance into and along the southern edge of the southwest quarter of Section 4. Some coal was extracted here by the Manhattan Company, and their workings are said to have extended in places as high as about three hundred feet above this gangway. But these old workings have long been caved and closed, and there is no very reliable information obtainable now as to their exact extent. The Manhattan Company also drove a tunnel from this gangway south to the Black Diamond Vein, and opened several hundred feet of a gangway on that bed, but never took out much coal from there.

The height of the lift in the Union Mine, between the Clark Vein Gangway No. 1 and the Clark Vein Gangway No. 2, is about three hundred and four feet; and throughout the Union Mine the Clark Vein is now exhausted down to the level of this latter gangway, which is only a few feet higher than the Lower Mt. Hope Gangway of the Black Diamond Company. Furthermore, the Union Company have continued their counter-slope some three hundred feet further down the dip and driven from its foot another gangway (their Clark Vein Gangway No. 3), from which, in 1876, they were working an additional lift of about three hundred feet of coal. This gangway was driven west only about eighteen hundred feet from the foot of the counter-slope when the mine was abandoned and closed in December, 1876.

There are no accurate records now obtainable of the extent of the workings in the upper part of the old Eureka Mine. But the Clark Vein was entirely cleaned out here as far up as it would pay to work towards the

outcrop, and it is evident from the situation of the slope and the shape of the hills at that locality that these workings must have extended in places to a height of some five or six hundred feet above the gangway which runs at the foot of their surface-slope. The Eureka Company also worked out through their counter-slope two additional lifts, aggregating some six hundred feet or more below this gangway, and cleaning out everything down to the top of the old Independent workings, from which point the distance down through the latter to the gangway at the level of the tunnel from the foot of the Independent Shaft must have been in the neighborhood of four hundred feet, since the total distance measured on the dip of the bed from this lowest gangway up to the gangway at the foot of the Eureka surface-slope was between one thousand and eleven hundred feet. Thus, for a certain distance here in the ground formerly owned by the Eureka and Independent Companies, the Clark Vein is practically exhausted to the depth of fifteen hundred or sixteen hundred feet measured on the dip of the bed from the outcrop down to the tunnel from the foot of the Independent Shaft. But a direct comparison of this distance with the distances down from the outcrop at other localities will not give the correct differences of absolute height between the bottoms of the mines, since the hills along the line of outcrop vary a good deal in height and rise considerably higher in the Union and Black Diamond properties than they do here in the old Eureka. In fact, the distance on the dip of the bed from this lowest gangway of the old Independent Company up to the level of Lower Mt. Hope Gangway of the Black Diamond Company would be about seven hundred and forty feet.

In the Pittsburg Mine the coal on the Clark Vein has been worked to heights ranging from six hundred feet, or less, to a maximum of between nine hundred and a thousand feet on the dip above the gangway which runs at the foot of their surface-slope, and above the highest of these workings the additional distance up, through soft and worthless coal and shale to the outcrop itself, is from two hundred to three hundred feet. Below the foot of the surface-slope there have been worked through the counter-slope in the Pittsburg Mine, three additional lifts, of three hundred, two hundred and seventy-nine, and two hundred and twenty-one feet respectively, making the total maximum depth worked on the Clark Vein in this mine, measured on the dip, between seventeen hundred and eighteen hundred feet; and below the lowest Pittsburg Gangway it will still be about five hundred and thirty feet farther down the dip, to the level of the tunnel from the foot of the Independent Shaft.

The Little Vein.

Before speaking of the workings on the "Little Vein," it will be well, for the sake of clearness, to describe two tunnels in the Black Diamond Company's property, which are driven from daylight south into the hills, and run nearly level through the superincumbent strata to the Black Diamond Vein. The first of these is known as the Upper Black Diamond Tunnel. This is the highest and the oldest of all existing openings to the Black Diamond Vein. Its mouth is in the right hand or southeast side, and near the bottom of the same ravine in which is situated lower down the mouth of the Clark Vein Hoisting Slope. It is distant from the latter a little over eight hundred feet, in a direction somewhat to the west of south, and is one thousand and thirty-four feet above low water level. It is also some little distance to the south of the line of outcrop of the Clark Vein. The tunnel is straight, and runs in a direction about 2° east of true south

for a distance of four hundred and twenty-two feet to the Black Diamond Vein. At a point one hundred and twenty feet from its mouth, it cuts a seam of coal, which is at this locality fourteen inches thick. At a point one hundred and ninety-six feet from its mouth it cuts another and smaller seam. These two are the only seams of coal exposed in the Upper Black Diamond Tunnel above the Black Diamond Vein; the rest of the strata consisting of sandstones and shales.

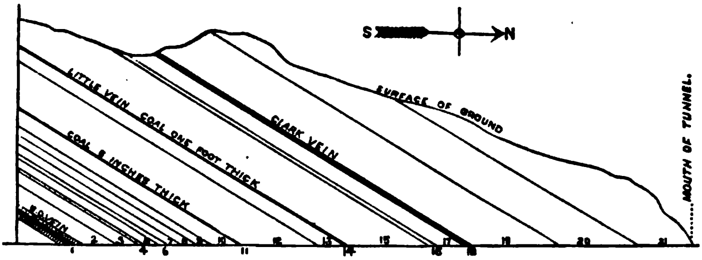
The second of the two tunnels now in question has been already mentioned, and is known as the Clayton Tunnel. Its mouth is in the bottom of the ravine, about one hundred and sixty feet southwesterly from the mouth of the Mt. Hope Slope, and is seven hundred and ninety feet above low water. This tunnel is also straight, and runs about 4½° to the west of south, a distance of nearly eleven hundred feet to the Black Diamond Vein. It has an ascending grade of about one foot in a hundred going in. The distance in from its mouth to the point where it cuts the center of the Clark Vein is three hundred and sixty feet.

The following sketch shows a section of the strata as exhibited along the line of this tunnel. The various strata are numbered in the sketch to correspond with the numbers in the first column of the tabular description which immediately follows. The dip here being about 31°, the actual thickness of the strata is a trifle over one half the distances which they occupy respectively along the level floor of the tunnel. In the last two columns of the tabular description, both these figures are given; the first one containing the respective level distances along the floor of the tunnel, and the last one the actual thicknesses of the various strata in feet and decimals of a foot:

Section of Strata on line of Clayton Tunnel.

Description.	Distance on Floor of Tunnel, in feet.	Actual Thickness of Strata, in feet.
1. Black Diamond Vein, forty inches coal, with seven or eight feet of bone above and below	35.0	18.0
2. Heavy-bedded sandstone—dry	66.5	34.2
3. Heavy-bedded sandstone—wet	40.0	20.6
4. Thin-bedded and ferruginous sandstone	4.0	2.0
5. Heavy-bedded sandstone—wet	31.0	16.0
6. Thin-bedded carbonaceous shales—dry	10.0	5.2
7. Numerous alternations of sandstones and thin shales; some of the latter carbonaceous—dry	35.0	18.1
8. Heavy-bedded sandstone—dry	20.0	10.3
9. Alternations of sandstone and thin shales, the latter sometimes carbonaceous—wet	25.0	12.9
10. Same alternations as in 9, but dry	45.0	23.2
11. Coal, five or six inches thick	1.0	0.5
12. Alternations of sandstones and thin shales—dry	139.0	71.6
13. Heavy-bedded sand-rock—dry	48.0	24.7
14. Coal, about one foot thick, with six inches of bone on each side of it	4.0	2.0
15. Heavy-bedded sand-rock—dry	146.0	75.2
16. Heavy-bedded sand-rock—dry	18.0	9.3
17. Coarse-grained sand-rock, generally heavy-bedded	64.0	33.0
18. Clark Vein, thirty-four inches of coal	5.5	2.8
19. Same sandstone as in 17	137.5	70.8
20. Fine-grained, bluish, and clayey rock, moderately heavy-bedded, with occasional bands of coarser sand-rock a few inches thick	127.0	65.4
21. Thin-bedded clay shales, to mouth of tunnel	93.0	47.9

Between 15 and 16 in the above section there is a streak of carbonaceous shale one foot thick, and also a second one of about the same thickness between 16 and 17.



SECTION OF STRATA ON LINE OF CLAYTON TUNNEL.

As there are two little seams of coal above the Black Diamond Vein in the Upper Black Diamond Tunnel, so also there are two little seams in the Clayton Tunnel between the Black Diamond Vein and the Clark Vein. But it will be seen, on closer inspection, that the positions of the upper and lower little seams in the two cases do not correspond to each other respectively. In fact, their distances from the middle of the Black Diamond Vein are such that the lower seam in the Clayton Tunnel corresponds closely in position with the upper seam in the Upper Black Diamond Tunnel; while there is no seam in the Clayton Tunnel corresponding to the lower one in the upper Black Diamond Tunnel; and furthermore, the mouth itself of the latter tunnel appears to be further south by some sixty feet than the proper position at this level for the upper seam of the Clayton Tunnel. Therefore, as the distance between these two tunnels in the direction of strike of the beds is only some three or four hundred feet, and as no faults of any magnitude have been discovered within this distance in any of the workings on either the Clark or the Black Diamond Vein, it is extremely probable that the lower seam in the Clayton Tunnel is really identical with the upper one in the upper Black Diamond Tunnel, in spite of the fact that if we considered the respective thicknesses of the seams alone we might be induced to draw an opposite inference. Moreover, the entire disappearance of the lower little seam of the upper Black Diamond Tunnel within the short distance of less than four hundred feet between it, and the Clayton Tunnel, and the decrease in thickness of the upper little seam of the upper tunnel within the same distance, from fourteen inches to five or six inches only, are in perfect keeping with numerous other cases throughout the Mount Diablo mines, in which considerable variations in thicknesses of strata within short distances are matters not of doubt but of certainty, having been fully exposed by the underground workings.

It has been previously stated that the number of beds which have been profitably worked at the Mount Diablo mines is three; but it will be seen presently that there is a strong probability that at different localities two separate and distinct beds have been confounded under the general name of "Little Vein," and that the whole number of beds which have been more or less worked with profit, should therefore be stated at four.

There have been no "Little Vein" workings in the property of the Black Diamond Company, for the reason that in this portion of the field none of the little seams where cut by tunnels between the Clark and Black Diamond Veins have been of sufficient thickness to pay for working. But in the eastern part of the Union Mine, and also in the western part of the old Eureka Company's ground, one of these little seams reached a thickness ranging from sixteen to twenty-four inches of good coal, and has therefore been quite extensively worked, yielding an aggregate of perhaps from forty to fifty thousand tons of coal. This vein is, in all probability, iden-

tical with the upper little seam in the Clayton Tunnel; for the total thickness of the strata between it and the Clark Vein in the Clayton Tunnel is about one hundred and twenty feet, while the thickness between the Clark Vein and the "Little Vein," which has been worked in the Union and Eureka, as shown by the workings at two different localities, is in the Union ground about one hundred and seventeen feet, and in the Eureka ground about one hundred and nineteen feet. There can be no question about the Little Vein in the Eureka ground being identical with that in the Union, for the workings have actually connected with each other under ground. But at a point considerably farther east, in the Pittsburg Mine, and in the northeast corner of the northeast quarter of Section 9, a "Little Vein" has been worked to a considerable extent by means of a little slope driven down to it through the Clark Vein, at a point a few hundred feet southwest of the mouth of the main Pittsburg Slope already described. And here the thickness of strata as exposed in the little slope below the Clark Vein, and above the Little Vein, is about two hundred and fifteen feet. It is probable, therefore, that this "Little Vein" is a different seam from the one in the Union and Eureka grounds, and that it underlies the latter.

The Black Diamond Bed.

The chief openings to the Black Diamond bed, with the exception of the two tunnels already described, do not run directly out to daylight, but are in the shape of tunnels entirely underground, driven south from various gangways on the Clark Vein.

The Black Diamond Company has four such tunnels. Two of these run south directly from the Black Diamond Shaft. The first or upper one, known as the "Black Diamond Tunnel, No. 2," is at the level of the Mount Hope Gangway, which it intersects at a point two hundred and sixty feet south of the center of the shaft. The second, and lower one, known as the "Black Diamond Tunnel, No. 3," starts from the foot of the shaft at a point about six feet higher than the level of the Lower Mount Hope Gangway, so that the cars from this tunnel will run on to the upper platform of the double-decked cage which receives at the same time on its lower platform the cars from the Lower Mount Hope Gangway.

From the south ends of these tunnels, gangways are driven both east and west on the Black Diamond Vein, and are known respectively as the "Black Diamond Gangway, No. 2," and the "Black Diamond Gangway, No. 3." The gangway described hereafter, at the south end of the Clayton Tunnel, and formerly known as the "Lower Black Diamond Gangway," being now called the "Black Diamond Gangway, No. 1."

About two thousand one hundred to two thousand two hundred feet west from the shaft, two other tunnels are driven south to the Black Diamond Vein, one from the Mount Hope, and the other from the Lower Mount Hope Gangway. These tunnels are known respectively as the "West Black Diamond Tunnel, No. 2," and the "West Black Diamond Tunnel, No. 3."

In the Union Mine, a tunnel runs south from the Clark Vein Gangway at the foot of the surface-slope, and in line with that slope to the Black Diamond Vein; and a lower tunnel to the same vein runs south from the gangway on the Clark Vein next below the one at the foot of the surface-slope, and is about seventy-five feet east of the counter-slope already described in this mine. From the south end of the upper one of these tunnels a gangway was driven a few hundred feet to the west; but the driving of this gangway was stopped when it was found that it was south of the section line, and therefore in ground belonging to the Black Diamond Com-

pany. From the south end of the lower tunnel, a gangway has been driven a long distance west, and a considerable lift of coal worked out above it and between it and the section line.

From the south end of the upper Black Diamond Tunnel already described, in the ground of the Black Diamond Company, a gangway was driven a few hundred feet to the east, and over three fourths of a mile to the west.

From the south end of the Clayton Tunnel the Black Diamond Gangway, No. 1 (formerly known as the "Lower Black Diamond Gangway"), was driven west considerably over three fourths of a mile, and east a little less than three fourths, making the total length of this gangway something over a mile and a half. This is the longest single continuous gangway which exists in the Mount Diablo mines. For a short distance at its eastern end, it runs along but a few feet below the level of the old Manhattan Gangway on this bed, already mentioned, and driven many years ago; and this part of the Black Diamond Gangway, No. 1, was only driven for the sake of making a connection with the old Manhattan Tunnel for purposes of ventilation.

The Black Diamond Vein is everywhere a much more expensive bed to work than the Clark Vein. This is owing to the bad character of the immediate roof and floor of the coal. The whole thickness of the Black Diamond bed varies in different localities from six or eight to eighteen or twenty feet. But the greater portion of this thickness consists of interstratified clay—slate, and "bone"—the last word being a miner's term to designate a very impure, slaty, and worthless coal, which forms a weak roof and a bad floor, requiring much timbering and gradually swelling so badly on exposure to the air as to crush the timbers, and necessitate frequent cutting down of the bottoms of the shoots and the gangway floors. The workable coal, wherever it extends in the Black Diamond Vein, lies nearly in the middle of the mass forming the thick bed just described, and has bone and shale both above and below it. It generally attains its maximum thickness at those localities where the whole bed reaches its maximum development, or, in other words, where the workable coal is thickest; there, also, the "bone" and slate are thickest, both above and beneath it, and *vice versa*, where the total thickness of the bed is least, there the workable coal thins out or even disappears entirely and the whole bed becomes worthless. The coal itself, however, in this bed, wherever thick enough to be worked with profit, is generally clean and free from interstratified slate or "bone," and there have been considerable areas in the Black Diamond Vein which have yielded rather better, because harder coal than most of that produced by the Clark Vein.

Throughout the whole length of the upper Black Diamond Gangway, except for a little distance in the extreme western portion of the mine, the coal was good, and its thickness averaged about forty-four inches, though varying at different points from thirty-six to fifty-four.

The maximum height of the lift worked out above this gangway was about five hundred and seventy-five feet. But its average height was much less than this, amounting to not far from three hundred and fifty feet.

The height of the lift between the upper Black Diamond Gangway and the Black Diamond Gangway, No. 1, varied from a minimum of about four hundred and twenty feet at a point some four or five hundred feet west of the upper Black Diamond Tunnel, to a maximum of a little over five hundred and fifty feet in the western part of the mine. This increase in the height of the lift towards the west is due here, as well as on the Clark bed, to a decrease in the amount of dip as we go west.

There was a small patch of good coal left unworked above the top of the highest workings above the upper Black Diamond Gangway, which is now inaccessible from below, but which may possibly be worked out hereafter by means of a new and shallow opening from the surface of the hills; and there are also a few acres of good coal not yet worked out in the northwest quarter of Section 9, above the level of the Black Diamond Gangway, No. 1. But with these two exceptions, the Black Diamond Vein is already exhausted down to the level of the latter gangway.

The height of the lift between the Black Diamond Gangway, No. 1, and the Black Diamond Gangway, No. 2, at a point about five hundred and ninety feet east of the Black Diamond Tunnel, No. 2, is three hundred and fifteen feet. At the south end of the Black Diamond Tunnel, No. 3, the height of the lift from there up to the Black Diamond Gangway, No. 2, is three hundred and eighty-two feet.

From the south end of the Clayton Tunnel, westerly, along the Black Diamond Gangway, No. 1, the coal was worked continuously all the way, and the whole lift exhausted as far west as the gangway was driven. For a few hundred feet, however, to the west of the tunnel, the coal was not quite so thick as it was in the upper gangway, the average for the first eight hundred feet here being only about thirty-four inches; and at a point one thousand and sixty feet west of the tunnel there was a small fault, beyond which, for a distance of some three hundred feet, the coal was rather soft. But west of this the coal again was good and hard, and with an average thickness of probably forty inches, reaching in places a maximum of four feet and a half.

To the east of the Clayton Tunnel, the coal on this gangway was thinner, but maintained an average (though gradually diminishing) thickness of twenty-nine inches for a distance of some three hundred and thirty feet, becoming gradually, however, more and more streaked with "bone." Within the next fifty feet, it dwindled rapidly to only eight or ten inches in thickness, becoming entirely worthless, and at the same time so dirty as to be called no longer "coal," but "bone." From thence, eastward, for a distance of between eight hundred and nine hundred feet along this gangway, there was no coal of any value whatever, and the total thickness of the bed for a portion of the way was only some five or six feet, consisting entirely of slate and bone. But at a point about twelve hundred and fifty feet east of the tunnel, the coal again comes in, and then continues of fair quality and with a thickness ranging from two and a half to three and a half feet, for a distance of something like two thousand feet in the northwest quarter of Section 9. This quarter-section covers a massive hill, which rises to a height of a little over fifteen hundred feet above tide-water; and it is probable that the good coal in this hill, at about the central part of the quarter-section, extends to a height of nine hundred or one thousand feet on the dip of the bed above the present gangway. But it has yet been worked to a height of only about three hundred feet above the gangway; though at one point a shoot was driven up to test its quality some seven hundred feet above the gangway, and it was found to be good as far up as this shoot extended.

At a considerable distance to the east of the old Manhattan Tunnel, two or three other openings have been made to the Black Diamond Vein by means of tunnels and slopes driven by the old Eureka and the Pittsburg Companies in ground now belonging to the latter company, but the coal was not found thick enough and good enough to pay for working, and no mining of any account has been done there. It is only within the mile and a half already described, which is traversed from end to end by the

Black Diamond Gangway, No. 1, that the Black Diamond Vein has ever been worked with any profit.

FAULTS AND DISTURBANCES.

Throughout the Mount Diablo coal mines the beds are frequently more or less disturbed by faults and dislocations. Within the two and a half miles of profitable working, some seven or eight of these faults are of considerable magnitude, involving throws of from ten or fifteen feet to one hundred and fifty feet or more, and immediately outside of this two miles and a half, both on the east and on the west, there are disturbances of still greater magnitude. But besides these larger faults, the smaller disturbances scattered throughout the mines and involving well marked dislocations, or throws, of from five or six feet down to as many inches or less, are extremely numerous. These disturbances are generally most sharply defined, and may be most easily studied in the Clark Vein. Many of the smaller ones are entirely local in character, and extend but very short distances; and it is only a very few of the largest ones which appear to extend through the whole mass of strata between the Clark and Black Diamond Veins with sufficient uniformity in character and direction to render it possible to recognize with certainty the same fault in both the veins.

The longest distance which occurs anywhere in the mines without any fault or disturbance of noticeable magnitude, is a distance of about two thousand feet on the Clark Vein, stretching east from the Black Diamond Shaft into the western portion of the Union Mine. The foot of the Black Diamond Shaft itself, however, is immediately opposite the point where a fault, involving a throw of from fifteen to twenty feet down to the west, crosses the Lower Mount Hope Gangway. This fault, like most of the larger ones in the Mt. Diablo mines, has a northeasterly and southwesterly course, and its plane dips at a steep angle towards the northwest. It shows through all the upper works on the Clark Vein, and its position may be traced upon the mine-map by the sudden changes in the directions of the three successive gangways on that vein, where it crosses them. It is also probable, though not certain, that this fault extends through the intervening strata to the Black Diamond Vein, as there is a fault of several feet down to the west in the latter vein, which crosses the upper Black Diamond Gangway eight hundred feet west of the upper tunnel, and the Black Diamond Gangway, No. 1, at a point one thousand and sixty feet west of the Clayton Tunnel, running northeasterly and southwesterly, and in such a position that although not exactly in line with this fault upon the Clark Vein, yet by curving slightly, as it is very likely to do, through the intermediate strata, it may very easily connect with it.

To the west of this, for a distance of over three thousand five hundred feet there is no single fault upon the Clark Vein which equals it in magnitude, though there are many smaller ones.

In the Union Mine there are five large faults. One of these is to the east of the Union Slope; one is just west of it, and is a considerable downthrow to the west; the three others are still further west, two of them being upthrows to the west, and one, the largest of all of them, a downthrow of sixty or seventy feet to the west. Some of these faults, doubtless, also run through to the Black Diamond Vein; but they show themselves there in such modified forms that among the multiplicity of minor disturbances it is not easy to recognize them.

In the eastern part of the old Eureka Company's ground there is a large fault which, so long as this company continued to work, formed practi-

cally the dividing line between its underground workings and those of the Pittsburg Company.

At a point in the eastern part of the Pittsburg Mine, about nine hundred feet east of the foot of the Pittsburg Slope, a fault crosses the gangway larger than any of the preceding, and consists of an upthrow of something over one hundred and fifty feet to the east; and at the extreme eastern limit of the Pittsburg Company's workings, the gangway terminates at the wall of another fault, which has never yet been thoroughly explored, and perhaps never will be, but which, judging from the position of the outcrop of the Clark Vein, at points further east toward Stewart's Mine, must consist of an upthrow to the east of not less than three hundred to four hundred feet, and possibly more.

It would be both impracticable and useless to describe all the smaller disturbances scattered through these mines. But, as an illustration of the frequency with which they sometimes occur, the following description is given from actual measurement of a somewhat remarkable "trouble" which extends for some distance along the Clark Vein Main Gangway, in the western part of the Black Diamond Company's mines: beginning at a point about twenty-one hundred and ten feet west of the foot of the Little Hoisting Slope, we have first a jump of seven inches down to west; then—

20 feet further west, a jump of 17 inches up to west.
7½ feet further west, a jump of 6 inches up to west.
12½ feet further west, a jump of 12 inches down to west.
2 feet further west, a jump of 12 inches up to west.
6½ feet further west, a jump of 22 inches down to west.
34½ feet further west, a jump of 7 inches up to west.
2 feet further west, a jump of 16 inches up to west.
10 feet further west, a jump of 12 inches up to west.

Then for a short distance the ground is *very* irregular, and the coal entirely disappears, with the exception of a thin and irregular seam, which bends first up and then down to the west, to where the coal comes in on the gangway again, which it does with a jump down to west at a point about seventeen feet west of the twelve-inch jump last noted. We then have—

5 feet further west, a jump of 10 inches down to west.
4 feet further west, a jump of 29 inches up to west.
12 feet further west, a jump of 4 inches down to west.
2 feet further west, a jump of 4 inches up to west.
3 feet further west, a jump of 2 inches up to west.
2 feet further west, a jump of 5 inches down to west.
3 feet further west, a jump of 31 inches down to west.
14 feet further west, an irregular roll and jump resulting in a change of 30 inches up to west.
8 feet further west, a jump of 31 inches up to west.
22 feet further west, a jump of 42 inches down to west.

This was the last jump measured; but there were more of them, and the "trouble" extended some little distance further west. Throughout its whole extent, both coal and sandstone were of course very badly crushed, some of the latter being just ready to fall to powder and run like loose sand, and very little coal was obtained from here till, on going farther west, the faults became less frequent.

It sometimes happens that the same fault in different portions of its course varies considerably in the amount of its throw, showing that the displacement in such cases has involved a twisting of the strata. There is one notable instance of this kind in the eastern part of the Union Mine. In the upper workings here a fault of considerable magnitude runs about northeast and southwest, and at the highest point of the workings exhibits

itself as an upthrow of sixteen feet to the east. But it curves gradually to the north in going down, thus being convex to the east, while at the same time the amount of its throw gradually diminishes, until, at the point where it crosses the present lowest gangway in the mine, its course is about north and south, and its upthrow is only eighteen inches to the east.

With reference to the direction of throw in the faults, the general law holds pretty well throughout these mines, that, where the plane of a fault is inclined from the vertical, it is the hanging wall of the fault which has gone down. But this law, though general, is not universal, and cases are occasionally found here in which the throw is in the opposite direction.

The general line of strike of the beds, in spite of all faults and disturbances, is very straight for a distance of nearly a mile and a half in a direction about N. 86° W. (true course), from the Pittsburg Slope to a point about as far west as the middle of Section 5; and within this distance the dip does not vary greatly from 30°, ranging in general from 28° to 32°.

But, going west from the middle line of Sections 5 and 8, the beds and the strata *curve* far around in a gradual sweep to the south, while at the same time their dip gradually diminishes until it does not exceed 20°; and in the western part of the Clark Vein Main Gangway there were places where it was only 15°. The general form and shape of the beds as they lie in this part of the mines, therefore, is that of *warped surfaces*. And this state of thing produces, of course, a gradual divergence of the gangways of each bed from each other, and a gradual increase in the height of all the "lifts" in going west.

This great curve of the beds to the south, in the western part of the mines, is evidently preliminary to a great and sudden disturbance of the strata, which is proven by other evidence to exist in the eastern halves of Sections 6 and 7, and within a short distance to the west of where the mines have stopped. But none of the gangways, on either the Clark or Black Diamond Vein, were driven far enough west to actually encounter this great disturbance. They were stopped because, for various reasons, it was not profitable to drive them further. In the upper Black Diamond Gangway, the coal still kept its place and thickness, but had grown rather soft and friable, and in this expensive bed, with the disadvantages of a dip of only 18° to 20°, and nearly a mile of underground haulage, it would not pay to go further for coal of so poor a quality. The face of the Black Diamond Gangway, No. 1, struck a fault, the magnitude of which was not known; and though the coal here was of good quality, and over four feet thick up to the fault, yet the dip here, as well as in the upper gangway, was low, and the underground haulage was over a mile. So it was not considered advisable to drive further, upon the chances, in the face of the additional fact that the near proximity, though not the exact locality, of great disturbance to the west, was certain. In the Clark Vein Main Gangway the work was finally stopped because of a somewhat interesting fact of altogether a different kind. Here the Clark Vein gradually split into two portions, which grew thinner and thinner until they almost disappeared. At a point, probably a thousand feet back from the final face of the gangway, an almost imperceptible seam or parting first made its appearance in the middle of the bed. This parting at first was not thicker than a knife-blade, and it ran a considerable distance before it presented any further special change. But then it begun slowly to increase in thickness, and gradually developed itself into a little layer of clay-slate. This change went on slowly for some distance, the coal above and below the slate being still good, but decreasing slightly in thickness, till at a point four hundred and eighty-five feet from the final end of the gangway, there were two

streaks of coal, each about one foot thick, with a few inches in thickness of slate between them.

Here the gangway struck the first jump of a series of small faults and rolls which continued for some distance, and there was a sudden increase in the thickness of slate between the two bands of coal. The gangway was still driven on, however, in the hope that the coal might come in again; but with prospects which only grew worse and worse—the coal growing thinner and the slate growing thicker—till at last the upper seam of coal was only about three inches thick, and the lower one six inches, while the clay-rock between them had increased to a thickness of about five feet. The work was then abandoned.

The exact condition of the face of the Mt. Hope Gangway when abandoned is not known to the writer; but it is evident in any case that it was driven far enough to the west, so that in the light of the development already made in the gangway next above, it was not likely to pay to drive it further. It probably went to the first of the series of little faults and rolls described above; for it stopped only about five hundred feet short of the Clark Vein Main Gangway itself.

To the east of the Pittsburg Slope a similar state of affairs exists in the strike and dip to that above described in the western part of the Black Diamond Company's mines, but on a somewhat smaller scale, and in an opposite direction. Though broken in the middle by a large fault, the gangways here run far to the south of east, and the dip also in the eastern part of the Pittsburg Mine is considerably less than it is in the vicinity of the slope. Moreover, as already stated, the works at the end here abut directly against the wall of a great upthrow of some three or four hundred feet to the east.

Ventilation.

In mines situated as these are, with a general dip of about 30°, among high hills and deep cañons, there is rarely much difficulty in securing good ventilation, if the matter be properly attended to, and the only artificial means in general use to aid the natural ventilation at the Mount Diablo mines is the keeping of fires at the bottoms of the ventilating shafts. In only one instance has mechanical ventilation been resorted to on any considerable scale. In the Lower Mount Hope Gangway, to the westward of a point about twenty-two hundred and fifty feet west of the Black Diamond Shaft, all the water (and its quantity is considerable) which issues from the roof and floor of the Clark Vein, besides being a solution of sulphates, is supersaturated with sulphuretted hydrogen to such an extent that on exposure to the air it rapidly forms white deposits of sulphur everywhere, while the excess of gas escaping contaminates the air so much as to cause serious trouble by its effect upon the eyes, which it quickly renders sore, inflamed, and almost blind, probably by reason of its decomposition with the formation of minute quantities of sulphurous and sulphuric acids in contact with the moisture of the eyes. It was found impossible, with the ordinary means of ventilation employed here, to send a sufficient volume of air through this portion of the mine to keep it clear enough of sulphuretted hydrogen to enable the men to work more than a very few hours at a time without becoming nearly blind. The trouble at last became so serious that the men absolutely refused to work there without better air.

The experiment was tried for a few days of keeping chloride of lime exposed to the air throughout that portion of the gangway affected, with a view to decompose and absorb the deleterious gas; but for some reason it

appeared to fail to accomplish the work, while the men complained that the pungent odor of the chloride of lime, in addition to the sulphur gas, only made matters worse. Then one of the largest sizes of Root's patent rotary blowers was obtained, and, driven by a small steam engine, was set to forcing air through a pipe down the Black Diamond Shaft and into that part of the mine, the air afterwards finding its exit from the mine through a ventilating shaft connecting with the western part of the Mount Hope Gangway. This made a decided improvement, but was yet far from being satisfactory. The action of the blower was therefore reversed, and it was made to exhaust the air, which then entered the mine through the ventilating shaft just mentioned. This did much better, and the work in this part of the mine was resumed and continued, though slowly and with difficulty; for the blower, after all, only partially removes the gas, enough of which still remains to make it very troublesome.

There is a little fire-damp in all the beds of the Mount Diablo mines, and there are now and then localities which it is necessary to watch pretty closely. But the quantity of this gas has never been great enough to necessitate the general use of the safety-lamp in the workings; and it has, therefore, only been used as a precautionary means for testing the presence of the gas in certain localities where it was known that small quantities of it were liable to collect. Numerous small casualties, resulting in the more or less severe burning, and occasionally in the death of one or two men have, however, occurred here from time to time, from explosions of fire-damp, nearly all of which have originated in the gross carelessness of the sufferers themselves in going with naked lights into the top of blind shoots or other places which had been standing idle for awhile, and where they knew, or ought to have known, that fire-damp was liable to be present. But besides these minor casualties there have also occurred, during the history of the mines, three or four explosions of greater magnitude, which cannot be said to have resulted from the special ignorance or carelessness of individual miners. None of these explosions did much damage to the mines; but one or two of them have resulted in serious loss of life.

The worst one of all was the explosion, or more properly the burning, of July 24, 1876, on the Black Diamond bed, in the lower and eastern part of the Black Diamond Company's mines, which resulted in the death of eleven men. This was occasioned by a "blown out" shot. There was no explosive mixture present where this disaster occurred previous to the firing of the shot, for the men were working all along there with naked lights, and the ventilation was good and strong. But on the firing of this shot (which was a pretty heavy one, being a two and a quarter inch hole charged probably with from twenty to twenty-four inches of black powder) the flame traveled between two and three hundred feet along the face of the coal, following a crooked course through crosscuts, etc., developing a hardly noticeable amount of explosive force, but badly burning all the men whom it caught in its course and then asphyxiating both them and others by the after-damp which followed the flash. The cause of this explosion was probably twofold. First, it is well known that in coal seams containing fire-damp any diminution in the atmospheric pressure, whether sudden or gradual, is accompanied by a correspondingly sudden or gradual liberation of increased quantities of fire-damp from the face of the coal. It is more than probable, therefore, that the recoil, which in an elastic medium like the air, and especially in confined localities, must instantly follow the first impulse of the heavy concussion of such a shot, would liberate suddenly from the adjacent face of the coal a certain quantity of fire-damp, which might issue forth quickly enough and be sufficient in

quantity to catch fire either from the flash of the shot itself or from burning particles of coal dust ignited by that flash. Second, the part of the mine where this accident happened was very dry, and the shot itself must have raised in its immediate vicinity a dense cloud of fine coal dust. Now, recent experiments have shown that a mixture of fire-damp and air which contains far too little fire-damp to be capable of either exploding or burning by itself alone becomes readily explosive if mixed with a sufficient quantity of impalpably fine coal dust. There is every reason, therefore, to believe that the propagation of the flame in this instance was effected by an intimate mixture of the air with a certain quantity of fire-damp and a dense cloud of coal dust, the presence of the last two of which was mainly due to the concussion of the shot itself; and the whole affair is strongly illustrative of the danger of the use of powder in coal seams where fire-damp is known to exist.

The Mt. Diablo coal is liable, under favorable circumstances, to spontaneous combustion; and, in the Black Diamond bed, it is always necessary to shut up the old workings so as to prevent access of air to the gob, which would otherwise heat and eventually take fire; but in the Clark bed, with its freedom from "bone" and its good sandstone roof and floor, no such precaution has been found necessary.

Haulage, Storage, and Transportation.

The gauge of the mine-tracks is different in the different mines. In the Pittsburg Mine it is twenty-six inches; while in the Black Diamond Mines it is three feet. The size and shape of the mine-cars employed also varies somewhat in the different mines. The inside dimensions of those used by the Black Diamond Company are six feet six inches long, two feet six inches wide, and two feet eight inches high. These cars are built of wood, banded with iron, and hold about a ton each of loose coal.

In the Black Diamond Company's mines, the underground hauling is done entirely by horses and mules, but in some of the other mines, and especially in the Union and Eureka, a great deal of it has been done by hand, the men pushing the cars.

No coal-breaking machinery has ever been used or needed here. In fact, one serious trouble with this soft coal is that it crumbles too easily and makes too much slack without any other breaking than that which it necessarily gets in mining and handling.

The bunkers at the mines are furnished with screens which separate the marketable coal into two sizes only, known as "coal" and "screenings," respectively. But this screening is often very imperfectly done. The slack which falls through the finest screen is generally thrown away, though within the last few years considerable of it has been burned under the boilers at the mines, and occasionally a little of it has been sold for various purposes. The Black Diamond Company's bunkers are also furnished at the top with automatic dumping arrangements, so that the mine cars dump themselves into the bunkers. The size of the bunkers varies, of course, with the requirements of the different mines. The largest one ever built here is that which receives the coal from the Black Diamond Shaft. This bunker has a capacity of about sixteen hundred tons, *i. e.*, eleven hundred tons of coal and five hundred tons of screenings. It stands at a distance of some five hundred feet or more from the mouth of the shaft, and the loaded cars are hauled to it and the empty ones hauled back to the shaft by an endless wire rope worked by a clip pulley, which is driven by a small steam engine. The floor of this bunker has a pitch of 33°, and the vertical

height between the mine car track above it and the railroad track beneath it is eighty-four feet.

The Black Diamond Railroad is a trifle over five and eight tenths miles in length. Of this, the first two and eight tenths miles from the river to the edge of the hills is straight and has a grade which, though not uniform, being less near the river than it is near the hills, nevertheless averages for the whole two and eight tenths miles about sixty feet to the mile. The remaining three miles in the cañon, from the edge of the hills up to Nortonville, is very crooked, and has an average grade of about one hundred and ninety feet to the mile. The maximum grade, however, is much heavier than this, and is situated at the upper end of the road nearest the mine, where, for a distance of five eighths of a mile, the uniform grade is two hundred and ninety-three and three fourths feet to the mile. The minimum radius of curvature in this road is three hundred and twenty-one and one fourth feet, corresponding to about an 18° curve. This, also, is at the upper end of the road, leading to one of the bunkers. Its use was necessitated by the position of the bunker and the narrowness of the cañon. It is just about as sharp a curve as the locomotives employed here will travel on without leaving the track.

The cars now employed on this road have flat wooden bottoms, with rectangular sheet-iron sides and ends strengthened with angle iron. One of the ends consists of a door, hung from a bolt which runs across the top, and furnished with a strong latch on each side. The cars are four-wheeled. Each car occupies about ten feet of track, and stands about six feet two inches high above the rails. The interior dimensions of the car body are as follows: length, eight feet; width, six feet four inches; height, three feet four and one half inches. These cars weigh, on the average, about four thousand pounds apiece, and each car carries from ten thousand to eleven thousand pounds, or a trifle over four and one half tons of coal. From twelve to sixteen of these cars form an ordinary coal train. The locomotive merely hauls the empty cars up to the mine. When loaded, the train runs down to the landing by its own gravity, and it needs, of course, careful attendance at the brakes to prevent it from running too fast. Indeed, whenever the track is muddy and slippery, as is often the case in the rainy season, it is found necessary, in addition to the most careful handling of the brakes, to sand the track to a greater or less extent before the descent of every train over that portion of the road which has the heaviest grade.

The Pittsburg railroad is of nearly the same length as the Black Diamond, and is very similar to it both in the distribution and in the amount of its grades and curvatures. The cars used upon this railroad are of iron, but of somewhat less capacity than those above described, and also somewhat different in construction, being arranged to dump through trap-doors in the bottom of the car, while the Black Diamond cars run on to a special dumping arrangement at the end of the wharf, which then tips up with the car upon it till the floor of the car makes an angle of 35° or so with the horizon, when the door at the lower end being unlatched, the coal runs out.

Pumping and Drainage.

There has never been any general system of drainage for the Mount Diablo mines; but each company has pumped out its own water independently of all the rest. In the year 1869 I made a careful survey to ascertain what could be done in the way of a drain tunnel, and found that a tunnel about seven thousand feet in length from a point in the Somersville Cañon to the Clark bed would drain all the mines of Nortonville and

Somersville to a depth of only about three hundred feet above low water in the San Joaquin River, or in other words, to a point a little below the lowest levels ever yet reached by the workings in any of the mines, excepting those from the bottom of the Independent Shaft.

This tunnel might have been driven for a cost of only about $50,000, and at the time when the survey was made there was talk of doing it. But the different companies to be benefited by it could not agree as to the exact proportion of its cost which ought to be paid by each of them respectively; and so after talking awhile to no purpose, the matter was dropped; since which time the Black Diamond, the Union, and the Pittsburg Companies have all three of them been lifting their water to points over five hundred feet vertically higher than the level at which this tunnel would have drained them all; and it is safe to say that from then up to the present time the aggregate cost of the item of pumping alone has been at least four or five times what the total cost of the tunnel would have been. And this is not, by any means, the only instance in which the existence and rivalry of so many different companies within so small a field, combined with short-sighted policy, and bad management in other ways, have caused the expenditure of large sums of money which are practically wasted, and which might otherwise have been saved to the owners of the mines. The Independent Shaft was a bad job, as well as a bad speculation, from beginning to end; and the new Black Diamond Shaft itself, with all its machinery, although a splendid piece of workmanship, was an unnecessary expense, inasmuch as the Mount Hope Counter-slope, which is large, commodious, well-timbered, protected by heavy pillars on either side, and furnished with a double track, and a pumping compartment besides, was already down to the same level as the present foot of the shaft before the sinking of the shaft was begun; and it would have been easy to have hoisted through this slope, at no greater expense than it will now cost to hoist through the shaft, all the coal that is likely to ever come up through the shaft.

It would be easy to point out many other ways in which money has been wastefully spent at the Mt. Diablo mines; but I will only mention here one other matter in this connection. Situated as these mines are, their whole extent from the eastern limit of the Pittsburg to the western limit of the Black Diamond Company's workings, was none too great for a single colliery; and if, in the early history of the mines, the various companies had combined into a single organization to control and manage the whole, then not only the Black Diamond Railroad itself, but also the whole establishment of shaft, slopes, and machinery for pumping and hoisting at the village of Nortonville would have been needless and superfluous, and their entire cost might have been saved; for a single railroad in the Somersville Cañon would have amply sufficed to transport all the coal which these mines have ever furnished, or ever will furnish; while, at the same time, every ton of it could have been brought to daylight in this cañon more cheaply than it has been brought to the surface at the various openings through which it has actually been extracted.

For this purpose, the tunnel above referred to as a proposed drain tunnel, which was never driven, should not only have been driven, but should have been made a large sized working tunnel and furnished with a double track and all other facilities for the rapid extraction of coal.

I do not think it is too much to say that if this had been done, and if the general management of the mines had been at the same time placed in the hands of a competent engineer, then the total production of these mines up to the present time (which amounts approximately to one and

three-quarter million tons) might have been furnished at an average cost price of one dollar less per ton than under existing circumstances its actual average cost has been. In other words, I believe that up to the present time the aggregate sum of one million seven hundred and fifty thousand dollars could have been saved to the owners of the Mount Diablo coal mines, if all the natural advantages which the situation of the field presented had been utilized with the best economy.

Peacock and San Francisco Mines.

To the west of the Black Diamond Company's mines, for a distance of a mile or two, there has been, in the past, considerable prospecting done for coal among the hills, and a number of slopes and tunnels have been driven some distance underground, at different points, upon the outcrops of small seams of coal. But nothing has ever been discovered here of any value, and the only two localities worth mentioning now are the old "Peacock," and "San Francisco" Mines.

The first of these was unquestionably upon the Black Diamond bed, and is situated about a quarter of a mile southwesterly from the extreme western limit to which the Black Diamond Company pushed their old "Upper Black Diamond Gangway." This gangway, at its face, when abandoned, was running S. 46° 30′ W., true course, or about S. 30° W., magnetic, and the dip of the bed at the same point was about 20° to the northwest. It will also be remembered that the "Lower Black Diamond Gangway," as well as the corresponding levels on the Clark bed, in this portion of the Black Diamond Company's mines, all show the same great curve of the strata here to the south in going west. Yet there is no sudden break of any considerable magnitude so far as those works extend. But at the Peacock Mine, only about a quarter of a mile distant, we find the bed striking S. 75° W., magnetic, and dipping to the north at an angle of 45°, thus proving that within this short distance there is a great disturbance of some kind, resulting in a sudden change of some 45° in the direction of the strike, and an increase of about 25° in the amount of dip.

I am not informed as to the full extent of the work which was done in the "Peacock," as it was already abandoned before I first saw it in 1868. But a slope was sunk for ventilation, and a tunnel was driven at least some eight hundred or nine hundred feet in length. The ground, however, was found to be badly broken and crushed, and the coal was soft and worthless.

The San Francisco Mine is situated about half a mile to the west of the Peacock. A slope was sunk here about three hundred feet, on a bed whose dip is about 41° at the surface of the ground, but increases to 50° at the depth of one hundred and sixty feet, from which point a gangway was driven east two hundred and seventy-five feet, and west about seventy-five feet. At the eastern face of this gangway the coal was about two feet thick, and had a course of N. 70° E., magnetic, and a dip of 65° to the north. Below this stratum of coal there was about six feet of soft clay-rock, and then another stratum of coal about one foot thick. Above it there was also another small streak of coal separated from it by a layer of clay-slate. Small faults were very numerous here, and the coal was soft and friable, and never paid to mine. A little of it was once hauled to the village of Pacheco, for sale. But as early as 1869, the work was already abandoned. It is very probable, though not certain, that this mine also is on the Black Diamond bed.

Central Mine.

Passing now to the eastward from Somersville, the first mine which we encounter is the "Central," better known, perhaps, as "Stewart's Mine." This mine is situated in a steep and narrow ridge, which runs nearly east and west across the northern part of Section 10, and the mine itself is in the northeast quarter of this section. It was originally opened by a level tunnel driven northerly from a point considerably beneath the line of outcrop of the beds in the steep and almost precipitous southern face of the ridge.

The course of this tunnel is just about north, magnetic, and its length to the Clark bed is about one thousand and thirty feet. It of course cuts through the underlying beds. The tunnel is not at right angles to the gangway, the course of the latter being somewhat to the north of west, magnetic. There are exposed in this tunnel, beneath the Clark bed, four distinct seams of coal, none of which, however, are here of any value. Starting from the Clark bed and going south along the tunnel towards its mouth, we find these seams as follows: The first one at a distance of one hundred and thirty feet shows eighteen inches of impure coal. The second one, about one hundred and fifty-seven feet further south, shows twenty-two inches of similar material. The third one, seventy-three feet further south, is nineteen inches thick; and the fourth one, supposed to be the Black Diamond bed, is one hundred and eighteen feet still further south. There can be no reasonable doubt, in spite of differences and diminished thickness in the section of the strata between them, that the two beds here called the Clark bed and the Black Diamond bed, respectively, are in reality the same beds as those which bear these names at Nortonville and Somersville. In this mine, some of the small beds between the two contain considerable gypsum in thin sheets and scales, filling seams in the soft and worthless coal. On the Black Diamond bed a gangway was once driven here some distance both east and west from the tunnel, and it is said that the bed was from three to four feet thick, and that about a thousand tons of coal were extracted from it, which, however, was of very poor quality, being both soft and "bony." It had been entirely abandoned previous to my first examination of the mine in 1869.

In April, 1870, a gangway had been driven here, on the Clark bed, two hundred and seventy-five feet east, and three hundred and seventy-five feet west from the tunnel, and a good deal of coal extracted, the bed averaging about thirty-nine inches in thickness, and dipping to the north at an angle of 28° or 29°. Just west of the tunnel, a large fault, consisting of an upthrow to the west, estimated at eighteen feet, crosses the gangway very obliquely, running northwest and southeast. To the west of this there were no more faults so far as the gangway was then driven, and the coal was bright and clean, but soft and friable. To the east from the tunnel there was a constant succession of small and irregular jumps all the way to the face of the gangway, and the coal here was badly crushed and very soft. Above this gangway the breasts had then been worked to a maximum height of about four hundred and fifty feet, the total distance on the dip of the bed, up to the outcrop, being about seven hundred feet. And some of the best, *i. e.*, the hardest, as well as the cleanest coal ever taken from the mine had come from the top of these breasts, up nearest the surface of the ground.

In connection with the popular fancy that coal must of necessity improve indefinitely in quality with indefinite increase of depth beneath the surface, it may be well here to state the fact that at Nortonville, the mines

have never, even from their lowest depths, produced any better or harder coal than was a great deal of that which came from the top of the very highest workings on the Black Diamond bed, more than five hundred feet above the old "Upper Black Diamond Gangway." And this is not all: It is true, as a general rule, throughout all the Mt. Diablo mines, that when a depth of from one hundred to three hundred feet is attained, measured on the dip of the bed from the outcrop, there is after and below that no further improvement in the quality of the coal which can be shown to be to any extent dependent upon or connected with the additional increase in the depth.

Since 1870, a tunnel has been driven in Stewart's Mine from the Clark bed northerly entirely through the ridge and out to daylight on its northern side. Since the completion of this tunnel all the coal mined has been taken out through it, thus saving some two miles of cartage around and over the hill.

It is not probable that this mine has ever been a profitable one to work. And though it has produced in the aggregate a considerable quantity of coal, it has not been worked continuously, but irregularly and spasmodically, sometimes lying idle for many months, and then again producing as high as from nine hundred to one thousand tons of coal per month. After this sort of fitful life for some eight or ten years, it has recently again shut down, and it is doubtful whether it will ever be much more worked hereafter.

Going east from Stewart's Mine, we next find in the bottom of a cañon near Cochrane's house and close to the center of Section 11, the outcrops of two beds, which in all probability represent the Clark bed and the Black Diamond bed respectively. At this point the beds run very nearly east and west, and dip to the north at an angle which Cochrane states to be about 32°.

Some prospecting was done at this locality years ago, but the coal was not found good enough to warrant mining.

Beyond Cochrane's, as we go east, the thickness of the strata and the characteristics of the various beds themselves change so much that, though there is, of course, no lack of positive opinion on the subject among some of the men who are pretty familiar with the ground, and though there are here and there a few facts known which really do point to some probability in the matter with reference to certain beds, yet it is impossible, in the light of all the developments hitherto made, to recognize anywhere, with any certainty, a single bed as being identical with either the Clark or the Black Diamond bed of the Mount Diablo mines.

The next development to the east of Cochrane's, is in the northeast part of the southwest quarter of Section 12. Here a slope was sunk about two hundred feet, some years ago, in a direction of north 16° west, magnetic, upon a bed of coal with a pitch of about 27°. There was no coal visible here at the surface of the ground, but only a slightly carbonaceous shale for the first eighty or ninety feet. But then the coal began to come in, and at the bottom of the slope there is said to have been three feet of pretty clean, though rather soft, coal, with a good sandstone roof. It is also said that two small schooner loads were once shipped from the bottom of this slope.

Empire Mine.

The next development is at the locality now known as the "Empire Mine." This is in the southwest part of the southeast quarter of Section 12.

A slope was originally sunk here about two hundred feet in 1860 or 1861,

when the work was stopped by the influx of water which the parties had not the means to handle. There was visible here at the surface of the ground only a little streak of soft clay-shale about eight or ten inches thick, which was of rather a light yellowish hue, being but very slightly colored by carbonaceous matter, and having sandstone immediately above and below it. This could not be called a very promising outcrop, certainly. But, on going down, it was found that this streak of shale increased steadily and rapidly in thickness, and also grew rapidly more and more carbonaceous, till, at the depth of one hundred feet slope distance, it had already developed into a four and a half foot bed of what might very properly be called coal, though it was still impure and very soft and friable. Its quality still continued to improve rapidly to the bottom of the slope. It was, however, abandoned.

But in the year 1875, Mr. George Hawkshurst, the Superintendent of the Union Mine, at Somersville, in connection with one or two other parties, again took hold of this old slope, cleaned it out, enlarged it, furnished it with a double track, put up pumping and hoisting machinery, and sunk it to the depth of six hundred feet (slope distance), and then drove a gangway both ways from its foot.

My last visit to this property was December 11, 1876. At this time the gangway was driven about three hundred feet west and nearly four hundred feet east from the slope, with a general course of N. 75° E., magnetic, the dip of the bed being about 23°, and the direction of the slope itself being N. 6° E., magnetic.

The coal along this gangway ranges from three feet six inches to a little over four feet in thickness. At the west face of the gangway it was four feet three inches thick. Of this, the upper twelve inches was tolerably clean coal; the next twelve inches was "bony," and the lower two feet three inches was clean coal, though rather softer than the average Mount Diablo coal. The floor of the bed is sandstone. Along the roof of it there runs a stratum of from five to eight inches of soft clay-slate, which, however, is not continuous, the solid sandstone sometimes coming down to the coal. Above this little streak of slate there is everywhere good solid sandstone. In the eastern part of the gangway there is one fault, which consists of a downthrow to the east of just about the thickness of the vein. West of the slope, there are only one or two little jumps, of a few inches each.

From a point a few feet east of the foot of the slope a tunnel was driven south some three hundred feet through the sandstone, in order to strike an underlying bed which had been previously discovered by a little shaft sunk about ninety feet south of the mouth of the slope, and one hundred feet deep. This bed, as seen in the shaft, is said to consist of three feet of good, clean coal, like the bottom bench of the upper bed, without any "bone," and with good sandstone roof and floor. This bed they had not yet reached in the tunnel at the time of my visit, though at a distance of a little less than two hundred feet from the upper bed they had passed through a small coal seam, about eighteen inches thick. Since that time, however, they have struck the lower bed in the tunnel, and found it, as I am told, to consist here of a bottom bench of twenty-two or twenty-three inches clean coal, overlaid by about fourteen inches of worthless "bone." The appearance of this "bone" at the depth where the tunnel strikes it, while there was no "bone" at the bottom of the little shaft so much nearer the surface of the ground, is not an encouraging fact with regard to the future prospects for a mine upon this bed.

At a point some six hundred feet south of the mouth of the slope, and

very close to the section line between Sections 12 and 13, there has been another little shaft sunk about ninety feet, and from the bottom of it a drill-hole was pushed some thirty feet lower. They are reported to have passed through several little streaks of coal in this shaft, and at the bottom of the drill-hole to have struck something which they believe to be the Black Diamond bed, as they assume the bed upon which the slope is sunk to be the Clark bed, and the one struck in the tunnel to be one of the "Little Veins" between the two. But this assumption, though not improbable, is, as already stated, by no means proven.

A recent survey shows that the mouth of the Empire Mine is about four hundred feet above tide-water, and that a railroad from there to the village of Antioch, on the San Joaquin River, will be about five and a half miles long, and will have two tunnels, aggregating something over one thousand feet in length. It is the present intention of the owners to build this road.

Teutonia Mine.

Next east of the Empire Mine comes the old "Teutonia." This is in the south part of the southwest quarter of Section 7, T. 1 N., R. 2 E., the mouth of the mine being only about one hundred aud fifty feet north of the section line. This mine was furnished with steam hoisting and pumping machinery. But at the time of my first visit to it in September, 1869, it had already been idle and abandoned for some two years, and nothing has been done there since. According to the best information which I have been able to obtain, however, relating to this mine, the slope, which was furnished with a double track and with sheet-iron mine-cars, went down upon a bed of coal about four hundred feet, with a pitch of about 26°. From the bottom of the slope a gangway was driven east something like one hundred feet. Just west of the slope the bed was broken by a large fault jumping up to west, beyond which the work was never carried. The bed was about thirty-six inches thick, the lower half of it being bright, clean, shelly coal, not very hard, and the upper half being "bony." It will be noticed that this description of the bed itself is remarkably like that of the bed which was struck by the tunnel in the Empire Mine in the latter part of December, 1876; and it is indeed not at all unlikely that it may be in reality the same bed.

The fact is worth noticing here that on October 11, 1875, before the underlying bed had been found at the Empire Mine, Mr. J. Cruikshank (who is well informed as to the early work which was done in this region), in some notes which he gave me, placed the Teutonia Slope on a bed underlying the "Clark Vein," and located the outcrop of the "Clark Vein" itself at a point some distance to the north of the mouth of the Teutonia Slope.

On the northeast quarter of Section 18, T. 1 N., R. 2 E., there is another old slope, known as the "Israel Opening." This slope is said to be some two hundred feet deep, with a pitch of about 25°. It is said, furthermore, that at its bottom there was three feet of clean and tolerably hard coal, and that some rooms were opened and several cargoes of coal once shipped from here. It is supposed that this slope is on a bed which underlies the one on which the Teutonia Slope is sunk.

On the northwest quarter of Section 16, T. 1 N., R. 2 E., there are several small openings, only one of which is worth mentioning now. This is a slope which runs down about north magnetic with an average pitch of 21°. It is said to be about two hundred feet deep, and also that at the bottom of it there were three feet of clean coal, with sandstone roof and floor. In December, 1876, the lower part of this slope was full of water, down to the

surface of which it was one hundred and thirty-five feet, and at this depth there was nothing like good coal to be seen, but only a streak of dirty "croppings" about one foot in thickness.

Rancho de Los Meganos.

On going still further to the east from here, there is for some distance hardly any exposure of the rocks at the surface, and there have never been any holes sunk until we reach the southeast quarter of Section 22, and the northeast quarter of Section 27, upon the Rancho de Los Meganos, in T. 1 N., R. 2 E. Here there are known to exist at least three beds of coal of workable thickness, associated with heavy deposits of a good quality of fire-clay.

A small shaft in the south part of Section 22, known as the "Hoisting Shaft," and eighty-eight feet in depth, shows the following section of the strata, the measurements being vertical, and beginning at the top or mouth of the shaft:

	Ft.	In.
Clay and clayey material	34	4
Black clay	14	8
Coal	2	4
White clay, hard and somewhat sandy	4	8
Coal	0	4
Blue fire-clay	5	0
Coal	3	6
Clay (with three regular coal seams, about one foot thick each)	8	0
Coal	7	0
Clay	3	0
Coal	1	2
Clay	4	0

There has been mined here, chiefly from the "seven-foot" and the "three and a half-foot" beds, through shallow slopes and shafts, without the use of other power than that of hand and horse, an aggregate of probably somewhere between five thousand and ten thousand tons of coal, most of which has been used under the boilers at the "Engine Shaft."

The general course of strike of the beds here is about N. 72° W., magnetic, and their dip to the northeast, but so far as yet explored, somewhat variable in amount, ranging from 16° to 26° at different points.

The "Engine Shaft" is sunk at a point about eleven hundred feet northeasterly from the line of outcrop of the beds, is about three hundred and eighty feet deep, and is divided into three compartments, two hoisting and one pumping, each compartment being eight feet by five feet clear, inside of timbers. The shaft is well timbered and is a good piece of workmanship. At its bottom there is a seven-foot bed of coal upon which a gangway was driven west in 1868, to a distance of two hundred and seventy-five feet from the shaft. No gangway was ever driven east from the shaft, and the foot of the shaft itself is in a fault which appears to be an upthrow to the east of considerable magnitude. Very little coal was ever mined from here, and what was taken out was burned under the boilers at the shaft. The quantity of water to handle here was pretty large, and the shaft was furnished with a Cornish pump, the pumping engine having a twenty-two-inch cylinder with forty-eight-inch stroke, and being geared four to one. The hoisting engine has 16″×48″ cylinder and is geared three to one.

It was but a few months after reaching the coal at the foot of this shaft, when, the company which owned the property getting into financial trouble, the work was suspended, and the shaft allowed to fill with water. Since that time it has been once again pumped out, and kept clear of water for a month or two, when, owing to similar causes, it was again allowed to refill.

And in this condition it has remained up to the present time, the water standing about forty feet below the mouth of the shaft.

It is believed by Mr. R. F. Lord, the engineer in charge of this property since 1871, as well as by Mr. Clarence King, mining geologist, who made a report upon it in 1874, to Mr. S. E. Lyon of New York, that the seven-foot bed at the foot of the engine shaft is entirely a different and separate bed from any of those upon which any mining has been done in the shallow workings near the outcrop, and that the latter beds, denominated by King the "Lord Series," underlie the former, the vertical thickness of the strata between the upper and lower seven-foot beds being supposed to be about one hundred and twenty-five feet.

But while this theory is not *a priori* particularly improbable, it is yet far from being proven to be true, and it is based upon facts which, after a recent careful examination of the ground by myself, and with my experience of over nine years of intimate acquaintance with the coal mines of the Mount Diablo region, I consider to be of very questionable import, and of little value.

It would be nothing wonderful if this seven-foot bed at the foot of the engine shaft (which bed consists, by the way, of three distinct benches of coal, separated from each other by two layers of clay-slate a few inches each in thickness) should eventually turn out to be identical with, and at this depth the only representative of, the whole series of beds which has been called the "Lord Series." But it is a question upon which the paucity and the doubtful significance of existing developments render speculation idle, and which additional underground explorations alone can finally settle. Whatever the fact may prove to be, however, in this respect, there can be no question in any case that the quantity of coal in the Rancho de Los Meganos is great. And, though I have never seen any coal in this property which was quite so hard, or which would bear handling and transportation so well as the average of the Mount Diablo coal, nevertheless, as it can be cheaply mined and cheaply sold, there is good reason to believe that it will pay to open up and work this mine, so soon as the property shall be freed from legal complications and a clean title shall be vested in some party who has both the money and the intelligence which it will certainly require to handle it properly.

With the Rancho de Los Meganos, the Mount Diablo coal field may be said to terminate, no explorations to the east or southeast of here having ever developed anything in the shape of coal worth mentioning until we come to another field, viz.:

The Corral Hollow Coal Field,

In the hills to the south of the Livermore Pass. There is a general description of this coal field, together with the developments which had been made here in the way of exploring and mining for coal up to the year 1862, in the volume of "The Geology of California," published by the State Geological Survey in 1865, pages 34 to 38, to which the reader is also referred.

In the year 1870 I visited the locality myself, in the employment of the State Geological Survey. In the eight years which had then intervened since Mr. Brewer's last visit, there had been considerable work done and a good deal of money expended in prospecting and mining for coal in the Corral Hollow Cañon, the results of which had only tended, however, to confirm the accuracy of the opinion expressed on page 36 of "The Geology of California," that "the disturbances of the strata in this district

were so extensive that it was to be feared that these coal beds would not be made available;" while the quality of the coal itself had also been proven to be somewhat inferior to that of the Mount Diablo mines, inasmuch as it is softer and more friable, and crumbles worse upon exposure to the atmosphere.

At the old Pacific Mine (otherwise called the "Eureka Mine," and "O'Brien's Mine,") no work had been done since 1862. Farther down the cañon, though my notes of the trip show many detailed observations of the strike and dip of the strata, as well as of the other visible surface indications, the only mention it is worth while to make of them here is the fact that they all confirm the statement that the strata are greatly disturbed. All the lower mines were already, at the time of my visit, in August, 1870, entirely closed and abandoned; and the best information I could obtain respecting the underground developments in them was from Mr. Carroll, who had lived here for some years, and was pretty familiar with the work that had actually been done. According to his statements, the old shaft of the "Commercial Company" (which is situated on the south side of the creek, some half or three quarters of a mile below the shaft of the old "Coast Range Company," described on pages 37 and 38 of "The Geology of California," was sunk about two hundred feet, and a tunnel was driven from its bottom about one hundred and eighty feet to the south. This shaft was not in coal, and the tunnel from its foot did not strike coal. A short distance below this point there is another shaft sunk to a depth of about eighty feet by Mr. Meader. This also was not on coal, and no drifting was done from it.

The next opening which we come to is the "lower shaft" of the Commercial Company. This shaft is in the coal, is about three hundred feet deep, and furnished all the coal which came from the Corral Hollow mines during the years 1869 and 1870. But at the time of my visit the hoisting works had recently been burned down, and the mine itself, as well as its waste heaps, was on fire. The dip in this mine was very steep to the south.

At the Almaden Mine, a little further down the cañon, there is a shaft about three hundred feet deep, and a tunnel was driven southerly from its foot about seven hundred feet, but no coal was found, except two or three seams of no value. Carroll thinks there is coal here to the north of the shaft. The dip here is southerly.

While this work was going on previous to 1870, the Western Pacific Railroad Company had also expended a few thousand dollars in laying down a track from Ellis Station to the mouth of Corral Hollow Cañon, in the hope of getting coal from these mines for use upon their locomotives, in which hope they were, not unnaturally, disappointed.

I have not heard of any further mining for coal in Corral Hollow Cañon since 1870; and the total amount of coal ever sent to market from this locality has been very small.

But outside of Corral Hollow Cañon, and yet within the limits of what may be properly called the Corral Hollow coal field, there has been some prospecting and a little mining done.

The Livermore Mine.

Within about a mile to the west of the Pacific Mine, and on the west side of the crest of the watershed which here divides the waters of the Livermore Valley from those of the San Joaquin Valley, there is situated the "Livermore Mine." At this mine, when I visited it in July, 1875, they

had sunk a slope of about three hundred and eighty feet upon a bed of coal whose strike was just about east and west, magnetic, and whose dip, though somewhat variable, averaged to the bottom of the slope about 40° to the north.

At the surface of the ground, there was visible here only a little black dirt; but the coal began to come in at a point about fifty feet below the mouth of the slope. At the bottom of the slope, when I saw it, the bed was about five feet thick, but contained three or four little streaks of clay, from half an inch to three inches thick. The coal itself was soft, and crumbled on exposure, like that of the mines of Corral Hollow Cañon. Some further work was done here in the latter part of 1875. A steam hoisting engine was erected, and bunkers were built, and some drifting was done underground, but the work has since been abandoned.

It is reported that since 1875 another coal discovery has been made at the so called "Summit Coal Mine," a short distance to the northeast from the Livermore Mine, and that considerable prospecting work has been done there, with promising results. But of this I cannot speak positively, not having seen the ground.

Other Coal Localities.

Outside of the Mount Diablo coal field there are numerous localities besides Corral Hollow scattered throughout the Coast Range of mountains from San Diego to Crescent City, and a number of localities also in the western foothills of the Sierra Nevada, in California, where more or less coal has been found. None of these localities have yet proven themselves to be of any financial value here, and the great majority of them would be utterly worthless in any country. I proceed, however, to mention a few, which either from their own intrinsic merit, or else from the noise which has been made about them, are worthy of special notice.

First—In the southern part of Los Angeles County, at a locality about twelve or thirteen miles easterly from the town of Anaheim, in the mountains on the south side of the Santa Ana River, not over a mile from the river, and at an altitude of some fourteen hundred or fifteen hundred feet above its bed, there are exposed in the precipitous mountain side some ten or twelve thin seams of impure coal, distributed through something like a hundred feet in thickness of shales and sandstones, no single coal seam being over about one foot thick. I visited this locality in 1872. The whole thing is worthless.

Second—It is said that there is a locality upon Los Gatos Creek, in the eastern flank of the Coast Range, in the southern part of Fresno County, where there are exposed no less than four or five beds which show in their croppings from three feet to four and one half feet respectively of a good quality of coal, which it would pay well to mine if it were within reasonable distance of a market. This locality I have not seen.

Third—There is in the hills on the south side of the little valley called Vallecitos, in the western part of Fresno County, and distant some five or six miles in a northwesterly direction from the New Idria Quicksilver Mine, a bed of coal which strikes N. 85° W., magnetic, and dips 80° to 85° to the south. This bed is certainly over seven feet in thickness, as, at the time of my visit in April, 1871, it had already been pierced to that extent by a tunnel which had not yet gone through it. This tunnel struck the bed at a depth only about forty feet below the surface of the ground. So far as exposed at that time, the coal was pretty uniform in quality throughout, and appeared but little contaminated with earthy matter. It, how-

ever, contained considerable gypsum in thin scales filling its seams, and it was soft and friable. But its quality was good enough, on the whole, to warrant a belief that it might, with proper arrangements, be used to some extent with advantage in the reduction of quicksilver ores at the New Idria Mine, where wood is scarce and expensive, though whether since then it has actually been so utilized, I am not informed.

Fourth—On the Middle Fork of the Eel River, about seven or eight miles south of the village of Round Valley, in Mendocino County, and in the northeast corner of Section 11, T. 21 N., R. 13 W., Mt. Diablo meridian, there is a bed of coal exposed, crossing the channel of the river in a direction N. 45° W. to N. 50° W., magnetic, and dipping from 20° to 30° northeast.

This bed is from fourteen to fifteen feet thick, and is all good coal with the exception of a single streak of shale in the middle of it, about five or six inches in thickness. The coal is immediately overlaid and underlaid by heavy beds of very fragile shales.

The shales above the coal are not far from seventy-five feet thick, and are overlaid by very hard and highly metamorphic rocks, containing large quantities of jasper and other silicious matter.

The shales beneath the coal are about twenty feet thick, and are underlaid by a bed of unaltered sandstone some ten or twelve feet thick, which again rests upon the same hard, metamorphic rocks which overlie the shales above. The whole thickness, coal and all, therefore, of the belt of unaltered strata which includes this coal bed, is at this locality only about one hundred and twenty-five feet.

The quality of the coal itself is a little better than that of the Mt. Diablo mines. In fact, it is the best coal which I have seen from anywhere in California, while at the same time this is the thickest bed of a marketable quality of coal that is yet known to exist within the State. Two causes, however, combine to render it improbable that it will ever furnish coal for the San Francisco market. In the first place, there is plenty of evidence close at hand that the rocks in that neighborhood have been greatly disturbed, and it is very uncertain how far the bed could be followed without being found crushed and broken up by faults, while at the same time extensive metamorphism of the rocks has been peculiarly localized and capriciously distributed throughout this region, and very irregular patches and belts of highly metamorphosed rocks alternate in all directions with no less irregular belts and patches which seem to have almost entirely escaped the metamorphic action. And, in the second place, the locality is in the heart of the Coast Range of mountains, and in order to reach it it would be necessary to construct a railroad for a long distance through a very rough region, which would render the cost of transportation so great that coal can be laid down in San Francisco from Washington Territory or Vancouver Island for less cost per ton than from here. There are said to be several other localities to the west and southwest from Round Valley where some croppings of coal have been found, but none of these are of any special interest.

Fifth—In the eastern part of Shasta County there is among the western foothills of the Sierra Nevada a region of considerable extent, including portions of several townships, where the volcanic materials which cap the mountain spurs and ridges are generally underlaid by a body of coal-bearing strata of recent origin. These strata consist of soft and unaltered shales and sandstones, and they are spread out unconformably over the upturned edges of the metamorphic gold-bearing slates which form so large a part of the mass of the Sierra. Their general position is not far

from horizontal, though at different points they dip gently in various directions, the angle of dip rarely, if ever, exceeding 6° or 8°. The aggregate thickness of these strata is probably not over one or two hundred feet, and they belong to that geological period which immediately preceded the commencement of volcanic activity in that portion of the range.

At a point in the northwest quarter of Section 20, T. 33 N., R. 1 W., Mt. Diablo meridian, there was in September, 1874, an open cut in a hillside, thirty-five feet long, beyond which a tunnel had been driven fifteen feet underground; and in this tunnel there was exposed a coal bed whose total thickness was twelve feet. This thickness was made up as follows, beginning at the top:

	Ft.	In.		Ft.	In.
Coal, slaty and worthless	1	6	Slate	0	4
Slate	0	6	Coal	0	4
Coal	0	7	Slate	0	2
Slate	0	5	Coal	1	10
Coal	0	11	Slate	0	4
Slate	0	3	Coal	0	4
Coal	1	2	Slate	0	3
Slate	0	3	Coal	0	6
Coal	0	1		—	—
Slate	1	10	Total	12	0
Coal	0	5			

What is here designated as "coal," however, was itself more or less impure, being often traversed by still thinner sheets of clay and dirt, whose thickness ranged from that of a sheet of paper up to half an inch, or so. It was also soft and friable, and disintegrated rapidly on exposure to the air. This to be sure was very close to the surface of the ground.

When I again visited the same locality, in April, 1876, this tunnel had been driven some thirty feet further underground, and then allowed to cave, and the place was inaccessible. I was told by Mr. Kincaid, who did the work, that at the face where he last stopped the coal was somewhat harder, and contained less slate than where I saw it in 1874. But heavy as this bed is, its quality at the best, so far as yet explored, is such that unless it improves very materially on driving further into the hill, it is not likely to pay to mine.

In the near vicinity of this point, also, there has been considerable other prospecting work done, and one tunnel has been driven some four or five hundred feet in length. But none of this work has developed so much coal as the open cut and tunnel just described.

I also saw more or less of coal croppings at various other localities scattered about through this region. For example, on Section 3, Section 7, Section 8, and Section 21, of this same township, also on Section 12, T. 33 N., R. 2 W., and also at a point which is probably in Section 9, T. 34 N., R. 1 W. Croppings are said to be exposed also in Section 27 and Section 28, T. 33 N., R. 1 W. But very little work has been done, however, at any of these localities, and no coal has yet been found which it would pay to mine.

Sixth—In Ione Valley, at the western edge of the foothills of the Sierra Nevada, in Amador County, there is a coal bed which has attracted some attention, at a locality which I visited incidentally in November, 1871, while more especially engaged in studying for the State Geological Survey the ancient auriferous gravels, which are so widely distributed over the western flanks of the Sierra.

This coal is also of very recent origin; quite probably, indeed, not older than some of the auriferous gravels themselves. The bed lies nearly horizontal, and ranges at different points from five or six to twelve or fifteen feet

in thickness. It is overlaid and underlaid by a very soft clay-rock, and its depth beneath the surface of the ground is small, being sometimes not more than thirty or forty feet. The material itself is strictly a lignite, still showing a good deal of the woody texture. It is not black nor lustrous, but of a dull earthy brown color, very soft and friable, and makes a large quantity of ash. Nevertheless, it burns very freely with a bright flame, and the ashes do not form any troublesome clinker. It has been employed for years as fuel for a flouring mill at Ione City, the distance to haul it being about three quarters of a mile. At the time of my visit, this mill, driven by a steam engine of fourteen-inch cylinder and thirty-six-inch stroke, was using no other fuel, and was consuming of this, as Mr. Hall, the proprietor, informed me, about three tons per day, costing less than a dollar and a half per ton at the mill. This was certainly very cheap fuel; and the Ione Valley coal will be likely to continue for many years to supply a certain moderate local demand for various purposes; but it will not bear transportation to any great distance, and it is not likely to ever compete with other coals in the general market. Since the beginning of 1876, a new mine has been opened here, and there has been a good deal of talk about it; but whether the quality of its coal is in reality any better or poorer than was obtained from the earlier workings I do not know, not having yet seen the mine myself.

Seventh—At the village of Lincoln in the Sacramento Valley, in the southwestern part of Placer County, there is also a coal deposit, of which great expectations have from time to time been entertained. I have never examined this deposit and do not know the extent of the work which has been done. But I have seen some of the coal which it has furnished, and such of it as I have seen was decidedly inferior in quality even to the Ione Valley coal; so poor, in fact, as to be practically worthless.

Eighth—At American Cañon, in the southwestern part of Solano County, there are, for some distance in the bluff along the right bank of the cañon, heavy but irregular croppings of black carbonaceous shale, containing streaks from one inch to eight or ten inches in thickness of coal. Most of these croppings, however, are not in place, as there has been more or less land-sliding nearly all the way along the steep face of the bluff.

The attempt has been made once or twice to organize a company to mine here for coal. But there has never yet been sufficient work done here to prove what lies in the solid hill back of the croppings. The locality would also be rather an expensive one to prospect satisfactorily, and the surface indications are not on the whole particularly promising. With reference, however, to transportation and proximity to market, the situation is a very favorable one if ever a good mine be found here.

Ninth—There have been occasional paragraphs in the newspapers, within the last year or two, with reference to the discovery of what has been asserted to be a heavy bed of a superior quality of coal in the range of hills next east of the Santa Rosa Valley in Sonoma County. But I am not aware that this discovery has yet proven itself to be of any value.

Tenth—In addition to all the foregoing, there have been numberless "coal discoveries" reported in the newspapers from time to time, in almost every corner of the State; but more especially in the Coast Range of mountains, and more particularly still in the counties of Santa Cruz and Monterey, and in the Contra Costa hills which stretch southeasterly from Carquinez Straits through Contra Costa and Alameda Counties, and in the foothills which skirt the southern and western flanks of Mount Diablo itself. And in very many, probably indeed in nearly all of these numerous localities, a little coal of some sort has actually been found. But none of

them all have yet proven to be of any practical value, and the statement still remains true to-day, as it has done in the past, that the only locality in California where coal has ever yet been mined with profit to any noteworthy extent, is at the old Mount Diablo mines.

But it is furthermore true to-day, of the Mount Diablo mines themselves, that all of them which have been profitable in the past have already seen their best days and are now rapidly declining; while outside of these old mines the most promising region yet known in the State is the eastern and yet unworked part of the Mount Diablo coal field, in which the most promising developments yet made are at the Empire Mine, and at the Rancho de los Meganos.

Chapter IV.—Miscellaneous.

Cost of Production at Mt. Diablo Mines.

The cost of mining and transporting the Mt. Diablo coal has varied very greatly, not only between the different mines, but also at different times and under varying circumstances for the same mine. The differences in this respect have been so great, indeed, that any single statement of the actual cost for any particular mine at any definite time would be of no value whatever as an index of the cost at the same time for a different mine, or for the same mine at a different time. This fact is well illustrated by the history of the Black Diamond Company. At their mines, the monthly averages of the cost per ton for labor alone in mining the coal and putting it into the bunkers at the mines, exclusive of the cost of timber and all other supplies, have ranged at different times since 1867 from a minimum of about $2 37 to a maximum of very nearly $4; or say, including supplies, from about $2 75 to $4 50, or a little more, per ton. Within the same time, the monthly averages of the cost of the railroad transportation from the mines to the landing have ranged from 25 or 30 cents to over $1 per ton; while the cost also of water transportation from the landing to San Francisco has varied between 37 cents and $1 25 per ton.

But then, again, these three items of cost for mining, for land transportation, and for water transportation, have rarely or never reached either their maxima or their minima values simultaneously, and consequently the actual highest or lowest figures of total cost for the mining, transportation, and delivery of the Mt. Diablo coal at any particular time would not be obtained by adding together separately either the highest or the lowest of the figures given above.

This total cost, however, has varied at different times since 1866, from a minimum of about $5, or possibly a little less, to a maximum of somewhere between $6 50 and $7 per ton. But for a general estimate of the total average cost of all the Mt. Diablo coal which has ever been sent to market, the sum of $5 75 per ton may be taken as a fair approximation.

It may also be stated in this connection, that the average loss of coal in the pillars and in waste of one kind and another in the working of the Mount Diablo mines has been, as nearly as it can be estimated, not far from 25 per cent. In other words, only about three fourths of the coal which the beds contained has been extracted and utilized throughout the whole extent of the works.

Statistics of Production and Trade.

In order to show as nearly as may be the growth and magnitude of the coal production and trade of the Pacific Coast up to the present time, I first present the following table which is here reprinted from the columns of the "San Francisco Commercial Herald and Market Review" for January 18, 1877, without further change than the omission of some insignificant items from Queen Charlotte's Island, Sitka, Saghalien, Fuca Straits, and Japan, which aggregate altogether only fifteen hundred and sixty-four tons:

ANNUAL RECEIPTS OF COAL AT SAN FRANCISCO.

Years.	Mount Diablo —Tons.	Coos Bay —Tons.	Bellingham Bay —Tons.	Vancouver Island —Tons.	Chile —Tons.	Australia —Tons.	English —Tons.	Cumberland —Tons.	Anthracite —Tons.	Seattle —Tons.	Rocky Mountain —Tons.	Total —Tons.
1860	....	3,145	5,490	6,655	1,900	7,850	6,640	5,970	39,985	....	....	77,635
1861	6,620	4,630	10,055	6,475	12,495	23,370	23,565	2,975	26,060	....	....	116,245
1862	23,400	2,815	10,050	8,870	5,110	12,590	16,055	4,970	36,685	....	....	120,545
1863	43,200	1,185	7,750	5,745	1,790	16,890	14,660	5,670	38,660	....	....	135,550
1864	50,700	1,200	11,845	12,785	2,323	21,160	18,330	7,275	41,680	....	....	167,298
1865	60,530	1,500	14,446	18,181	1,410	17,610	9,655	4,230	22,585	....	....	150.147
1866	84,020	2,120	11,380	10,852	1,480	53,700	7,400	9,524	12,124	....	....	192,601
1867	109,490	5,415	8,899	14,829	14,949	26,619	7,302	12,177	48,518	....	....	248,925
1868	132,537	10,524	13,866	23,348	8,511	31,590	29,561	2,292	29,592	....	....	282,025
1869	148,722	14,824	20,552	14,880	1,114	75,115	17,386	11,536	24,844	....	....	328,973
1870	129,761	20,567	14,355	12,640	7,350	83,982	31,196	9,322	21,320	....	....	320,493
1871	133,485	28,690	20,284	15,621	4,161	38,942	54,191	6,060	7,231	4,918	1,025	315,194
1872	177,232	32,562	4,100	26,008	3,682	115,332	29,190	10,051	19,618	14,830	1,862	434,467
1873	171,741	38,066	21,211	31,435	400	96,435	52,616	8,857	18,295	13,572	1,904	454,582
1874	206,255	44,857	13,685	51,017	....	139,109	37,826	15,475	14,263	9,027	433	531,947
1875	142,808	32,869	10,445	61,072	....	136,869	57,849	10,328	18,810	67,106	53	538,209
1876	108,078	41,286	21,335	100,965	3,150	131,695	121,948	12,520	11,871	95,314	226	648,388

This table requires, however, a few explanatory remarks. In the first place, with reference to all the coal which comes here by sea from outside the Golden Gate, *i. e., to all the coal which arrives here, except the Mount Diablo and the Rocky Mountain*, the figures in this table have been generally obtained by taking the reports of the vessels on their arrival, and before discharging, as to the quantity of coal they had on board; and these reports vary slightly in almost every cargo from the amount as actually weighed when the vessel comes to be discharged. These differences are, of course, small, and are sometimes in one direction and sometimes in the other. But on the average, and in the long run, it is probable that the first reports are slightly in excess of the actual quantities as weighed.

In the second place, it will be noticed that this table purports to give only the "*receipts of coal at San Francisco*," and this is what it actually does give with a good degree of accuracy for all the other coals excepting that from the Mount Diablo mines.

But the figures which it gives for these mines do not represent either the actual "receipts at San Francisco," or the total product of the mines. What they do represent, with a fair approach to accuracy, is *the total quantity which has been shipped away from the mines.* There is, and always has been, a large proportion of the product of the Mount Diablo mines which has been delivered on board of steamers and other vessels at Pittsburg and New York Landings, and which has been partly burned in steamers on the bay and rivers, and partly sent direct to Sacramento, Stockton, Vallejo, and other places, without ever coming to San Francisco; and all the coal so disposed of is included in those figures. But, on the other hand, they do not include the large item of consumption at and in the immediate vicinity of the mines themselves.

With reference to the mines of Oregon and Washington Territory, the figures in this table, being the receipts at San Francisco, represent pretty nearly nine tenths of the total production of the mines, the aggregate consumption at and in the vicinity of the mines, and also upon ocean steamers, being not far from 10 per cent of the production.

In the case of the Vancouver Island mines, the figures probably do not represent quite so large a proportion as nine tenths of the production; for, besides the town of Victoria and some smaller settlements, which draw their supplies almost entirely from these mines, the quantity of Vancouver Island coal which has been burned on ocean steamers is considerably larger than of Washington Territory or of Oregon coal.

With these explanations, the above table may be taken, except in the case of the Mount Diablo mines, for as good a general exhibit of the statistics of the coal production and coal trade of the Pacific Coast from 1860 to 1876, inclusive, as it is possible now to compile.

But, with reference to the Mount Diablo mines, having had better facilities than any mere statistician has had for knowing the truth about the mines and their operations, I have compiled the following table, which, with the accompanying explanations and remarks, may be relied upon as furnishing a more accurate statement, and a closer approximation to the total production of these mines than has ever yet been published, or than is likely to be compiled or published hereafter, for the first sixteen years of their existence.

It should be mentioned that in this table, as well as in the preceding one, all the figures are in tons of two thousand two hundred and forty pounds avoirdupois:

Years	Black Diamond	Union	Pittsburg	Eureka	Independent	Manhattan	Central (approximate only)	Estimated additional product	Total production
1861	1,370	--------	--------	--------	--------	------	--------	5,250	6,620
1862	10,672	--------	--------	--------	--------	------	--------	12,728	23,400
1863	14,232	--------	--------	--------	--------	------	--------	28,968	43,200
1864	12,421	--------	--------	--------	--------	------	--------	38,279	50,700
1865	14,491	11,187	--------	--------	--------	------	--------	34,852	60,530
1866	16,009	14,224	9,599	7,391	15,678	65	--------	21,054	84,020
1867	38,368	24,167	21,909	10,908	14,338	------	3,000	12,000	124,690
1868	70,100	21,641	22,920	15,815	--------	------	3,000	10,200	143,676
1869	79,548	17,274	27,938	16,945	--------	------	4,729	10,800	157,234
1870	70,668	20,563	23,958	10,246	--------	------	5,055	11,400	141,890
1871	75,536	17,209	22,339	18,194	--------	------	7,215	12,000	152,493
1872	103,008	21,494	26,714	16,831	--------	------	9,612	13,200	190,859
1873	104,596	22,600	32,362	4,075	--------	------	8,578	14,400	186,611
1874	117,804	30,002	43,546	--------	--------	------	9,000	15,000	215,352
1875	83,645	26,365	33,628	--------	--------	------	8,000	15,000	166,638
1876	63,048	24,000	21,801	--------	--------	------	3,000	16,200	128,049
	875,516	250,726	286,714	100,405	30,016	65	61,189	271,331	1,875,962

In the column here headed "Black Diamond" there is given, from the books of the Black Diamond Coal Company, the total production of their mines, excepting the amount consumed for hoisting and pumping under the boilers at the mines. It includes the local sales by the superintendents at the mines and at the landing, and the consumption by the locomotives on their railroad, as well as by their tug upon the river and bay.

The rest of the mines named in this table, with the exception of the "Central," all are located at Somersville.

The first shipments of coal from the Mount Diablo mines were in 1861, and besides the old companies at Nortonville, which were all afterwards purchased by the Black Diamond Company, and whose product is therefore included in the column headed "Black Diamond," several of the Somersville companies also began to ship coal in the same year, all the coal at this time and for several years afterwards being hauled to the landings by teams. The Pittsburg Railroad first began to carry coal from Somersville in March, 1866, and with the single exception of the Union Mine from the beginning of 1865, the best information which can now be obtained respecting the production of the Somersville mines prior to the completion of this railroad must be gleaned from the newspaper statistics, the old account books of these various companies, some of which were very loosely kept in the first place, having been long ago scattered about, and many of them destroyed.

In the column headed "Union," the production of that mine for the years 1865 and 1866 is given from the books of the Union Coal Company. The figures given for that mine subsequent to 1866, together with all the figures given for the Pittsburg, the Eureka, the Independent, and the Manhattan Coal Companies, are from the books of the Pittsburg Railroad Company, and show the quantities transported over the railroad from the different mines respectively. These quantities, however, do not represent the total production of the mines, inasmuch as they do not include, first, the local sales at Somersville and at Pittsburg Landing; second, the quantity consumed by the locomotives on the Pittsburg Railroad; and third, the consumption under the boilers for pumping and hoisting at the various mines of Somersville. The Manhattan Company shipped no coal after 1866; the Independent Company shipped none after 1867; and the

Eureka Company none after 1873. The Union Mine was also closed and abandoned about the first of December, 1876. The Central Mine stopped work in the early part of the year 1876.

In the column headed "Central (approximate only)," there is given, as nearly as it can now be ascertained, the product of the Central Mine. The figures in this column for the years 1869 and 1870 are accurate and from the books. For the remaining years they are estimates based upon the best information obtainable, and are "approximate only."

The figures in the column headed "Estimated Additional Product," are estimates intended to cover the following items: *First*—The total production from 1861 to 1864, inclusive, of all the mines except the Black Diamond, together with the local sales and consumption under boilers for those years at the mines of that company. *Second*—For 1865, the total production of all the mines except the Black Diamond and the Union, together with the local sales and consumption at the mines of those two companies. *Third*—For 1866, the quantity hauled by teams in the first three months of that year from all of the Somersville mines except the Union, the local sales at Somersville, the consumption by the locomotives of the Pittsburg Railroad, and the consumption under the boilers at all the mines; also, the production in that year of the San Francisco, the Peacock, the Central, and the Teutonia Mines. *Fourth*—From 1867 to 1876, inclusive, the consumption under boilers at all the mines, the local sales at Somersville and Pittsburg Landing, the consumption by locomotives on the Pittsburg Railroad, and the total product of all mines other than those specified in the table.

It will be noticed that the figures in this column from 1861 to 1866, inclusive, are such as to make the total production for those years equal to the amounts given for the same years in the table of the "Commercial Herald and Market Review." I have made them so, because I am disposed to believe that for these six years during which no very accurate accounts were kept, the figures in that table, though purporting to show only the "receipts at San Francisco," are, nevertheless, in all probability, large enough to cover the whole product of the mines.

In the estimate of sixteen thousand two hundred tons for 1876, there is included the product of the Empire Mine for that year, which, I am informed by one of its owners, was about three thousand tons. With this single exception, more than nine tenths of all the quantities given in this column of estimates for the ten years subsequent to 1866, were burned under the boilers at the mines for pumping and hoisting purposes, the items of local sales and consumption on the railroad being comparatively very small. The estimates are based upon a good general knowledge of the character and comparative magnitude of the operations at the different mines, and upon the fact that for several years past, although no accurate account of it has been kept, the consumption beneath the boilers at the mines of the Black Diamond Company alone is known to have averaged not far from six hundred tons per month.

Relative Values of Different Coals.

As the proximate analysis of a coal does not give the means of computing its calorific power, and as it furnishes at best but an imperfect means of estimating its practical value, I have not thought it worth while to reproduce here a table of hitherto published analyses of Pacific Coast coals. Those who are interested in these analyses will find them in the State Geological Survey Report—"Geology of California," vol. 1, p. 30, and

in a table compiled by Mr. Archibald R. Marvine, in the Annual Report for 1873, of the United States Geological and Geographical Survey of the Territories, by F. V. Hayden, pp. 113, 114. I will only present here two hitherto unpublished proximate analyses of Seattle coal, of which No. 1 was made for Goodyear & Blake, by Falkenau & Hanks, in April, 1868; and No. 2 has been furnished me by the President of the Seattle Coal and Transportation Company, and was made by Mr. H. G. Hanks, in May, 1875. They are as follows:

No.	Water.	Combustible Bituminous Substances.	Fixed Carbon.	Ash.	Sulphur.	Total.
1	11.66	35.49	45.98	6.44	0.43	100.00
2	6.70	38.32	47.99	6.49	....	99.50

Believing, however, that the results of careful working experiments upon a large scale, with reference to the relative practical values of the various coals which come to this market for steam purposes, would possess no little general interest and value, I have endeavored to gather as much reliable information of this kind as it was possible for me to obtain. In this direction I have not succeeded so well as I could wish. But I present the best information which I have, not because it is satisfactory, for it is not, but because it is all which I have been able to obtain, and because I believe that such as it is, and being reliable so far as it goes, it will not be without interest.

The most comprehensive information which I have upon this subject is embodied in the following table furnished me by the courtesy of Mr. Charles Elliot, the City Superintendent of the Spring Valley Waterworks, and giving the results of a series of experiments made at the pumping works of the Spring Valley Water Company, under his supervision at various times, extending over a period of between seven and eight years.

In this table, the first column shows the kind of coal employed. The second column shows the date, *i. e.*, the month and year, and in a few cases the day of the month of the experiment. The third column shows the duration of the experiment in all cases where such duration was noted, where it was not noted, the duration was in most cases a single day. The fourth column shows the "duty" performed; *i. e.*, the number of foot-pounds of useful mechanical effect produced by each hundred pounds of coal; or, in other words, as stated at the head of the column, the number of pounds of water raised one foot high by the combustion of each hundred pounds of coal:

Kind of Coal.	Date of Experiment.	Duration of Experiment.	"Duty," i. e., No. of lbs. Raised 1 foot high by each 100 lbs. of Coal.
Mt. Diablo (Eureka) screenings	June, 1869	....	23,678,000
Nanaimo coal (V. I.)	July, 1869	....	32,317,600
Mt. Diablo (Pittsburg)	Feb., 1870	....	24,850,450
Anthracite (Philadelphia)	Feb., 1870	....	37,600,000
Sydney coal (Australia)	May, 1870	....	40,032,000
Sydney coal (Australia)	June, 1870	....	36,350,000
Sydney coal (Australia)	Aug., 1870	....	37,036,184
Mt. Diablo (Union) screenings	Sept., 1870	....	25,588,636
Mt. Diablo (Union) screenings	Sept., 1870	....	26,333,557
Anthracite	Nov., 1870	....	40,657,500
Mt. Diablo (Black Diamond)	Dec., 1870	1 week	25,754,400
Mt. Diablo (Union) screenings	Jan., 1871	24 hours	28,102,173
Mt. Diablo screenings	May, 1872	24 hours	23,000,000
Bellingham Bay, screenings	June, 1873	23 hours	29,048,600
Sydney coal (Australia)	June, 1873	....	38,215,700
Seattle coal	June, 1873	....	29,630,000
Sydney coal (Australia)	Nov., 1873	1 month	36,660,000
Welsh coal	Dec., 1873	24 hours	40,880,000
Welsh coal	Dec., 1873	1 day	37,252,000
Welsh coal	April, 1874	....	34,300,000
Sydney coal (Australia)	June, 1874	30 days	38,000,000
Sydney coal (Australia)	July, 1874	7 days	38,889,200
Sydney coal (Australia)	Feb., 1875	7 days	38,681,250
Mt. Diablo (Black Diamond)	June, 1876	1 week	25,120,000
Welsh coal	Dec., 1876	234 hours	36,596,000

It is needless to remark upon one fact which all well informed engineers will promptly recognize on looking over the above table, viz.: that the pumping engines of the Spring Valley Water Company are very far from being up to the standard of the best pumping engines of the present day, so long as they yield less than forty-one million foot-pounds of useful effect for each hundred pounds of good anthracite coal.

But there is valuable information in the above table; and the experiments which it shows are, in spite of some rather wide variations, none the less valuable because of the internal evidence which they bear of being a true record of the best results actually obtained under the existing circumstances.

It will be seen that the "duty" of the same kind of coal varied largely at different times and in different experiments; that of the Sydney coal ranging from thirty-six millions three hundred and fifty thousand to forty millions and thirty-two thousand, and that of the Mount Diablo from twenty-three millions to twenty-eight millions one hundred and two thousand one hundred and seventy-three foot-pounds. It is safe to assume in general that the shorter the duration of the experiment, and the fewer the number of experiments with any given kind of coal, the less reliable will be the results respecting that coal. But the variations in this table are such as cannot be satisfactorily accounted for by differences in the duration of the experiments only. For instance, of two experiments with Sydney coal, each of which extended over one month's time, one gave a duty of thirty-six millions six hundred and sixty thousand, and the other a duty of thirty-eight million foot-pounds. It is, therefore, evident, either that the actual quality of the same denomination of coal varied considerably in the different experiments, or else, as in the light of the two consecutive experiments of December 1 and 2, 1873, with Welsh coal, seems

not improbable, that there was some irregularity in the performance of the engines themselves, which was due to causes that are not explained by the table.

If, now, without regard to the duration of the separate experiments which is stated in only twelve out of the twenty-five experiments given in the table, we take for each coal the sum of the duties, as given in the table for all the experiments with that particular kind of coal, and dividing this sum by the number of experiments, thus obtain a mean value for the duty of each of the different kinds of coal; if, then, we compare these mean values with each other, assuming for purposes of comparison that the value of the Mount Diablo coal is unity, and stating the values of the others in unity and decimals, we obtain the following relative values for the various coals included in the above table:

Mount Diablo coal (screenings)	1.000
Seattle coal	1.171
Sydney coal	1.502
Welsh coal	1.472
Bellingham Bay coal (screenings)	1.148
Nanaimo coal	1.277
Anthracite	1.546

In this statement of the relative values of the different coals, the figures which relate to the Mount Diablo and the Sydney are evidently the most reliable, as the experiments with these two varieties were the most numerous, there having been eight experiments with each. Next in order of reliability comes the Welsh coal with four experiments, then the Anthracite with two, and finally the Seattle, the Bellingham Bay, and the Nanaimo, with only one experiment each.

In addition to the preceding, Mr. Elliott has also furnished the following results of some very recent trials between the Seattle (W. T.) and the Wellington (Vancouver Island) coals at the same works. These experiments consist of five days' run with each of the two coals. The results could not be determined in foot-pounds, for the reason that the pumps were working under somewhat variable conditions of pressure-head, etc. For the same reason, the results of a comparison between any two single days' works only would not be very reliable. But the comparison of the means for the whole five days gives probably a very fair result. The experiments were as follows:

First, with Wellington coal, at $6 50 per ton:

11 hours run, cost	$5 25
12 hours run, cost	5 80
14 hours run, cost	6 38
11 hours run, cost	4 51
11 hours run, cost	5 80

Second, with Seattle coal, at $6 50 per ton:

14 hours run, cost	$8 00
13½ hours run, cost	7 40
14 hours run, cost	8 12
13 hours run, cost	7 45
13½ hours run, cost	7 45

It appears from this that with the Wellington coal the pumps ran fifty-nine hours, at a total cost of $27 74, or an average cost of 47.017 cents per hour for coal, while with the Seattle coal they ran sixty-eight hours, at a total cost of $38 42, or an average of 56.500 cents per hour.

This shows a relative difference in value between these two coals of about twenty per cent in favor of the Wellington over that of the Seattle coal. Or, if the Mount Diablo coal be considered as unity, the Seattle being 1.171, then the Wellington will be 1.407.

The following experiments, made under the steam boilers at the foundry of W. T. Garratt, in July, 1876, by Mr. H. M. McCartney, for the Seattle Coal and Transportation Company, have been kindly furnished me:

TRIAL OF COAL AT GARRATT'S FOUNDRY, SAN FRANCISCO.

JULY 27, 29, AND 31, 1876.

Coal.	Run.	Total Coal used.	Total Water used.		Total Ash.	Average Coal per hour.	Average Water per hour.		Amount of Coal required to evaporate one gallon or one pound of Water.		Amount of Water evaporated by one pound of Coal.		Per cent of Ash in Coal.
	Hours.	Pounds.	Gallons.	Pounds.	Pounds.	Pounds.	Gallons.	Pounds.	For one gallon of water—Pounds.	For one pound of water—Pounds.	Gallons.	Pounds.	
Wellington	9	1,581	1,175	9,778	135	175.67	130.56	1,086	1.346	.162	.743	6.185	8.54
Nanaimo	8½	1,576	1,208	10,053	164	185.41	142.12	1,183	1.304	.157	.766	6.379	10.41
Seattle	9	1,765	1,186	9,870	196	196.11	131.78	1,097	1.488	.179	.672	5.592	11.11

The time given in the "run" does not include the noon hour, but only the time during which the machinery was in motion. The Wellington coal made no clinkers to speak of, the Seattle very few, and the Nanaimo most of all. The latter was the only one which ran together and "caked" on the grates.

From these experiments, the Nanaimo coal would appear to be rather better than the Wellington, and if we still suppose the Mt. Diablo to be unity and the Seattle to be 1.171, we shall now find the Nanaimo to be 1.335 and the Wellington 1.295.

A comparative trial was made in December, 1874, as I am informed by the President of the Seattle Coal and Transportation Company, on one of the largest ferryboats in the bay of San Francisco, between Seattle and Mt. Diablo coal, with the following result: The boat first ran fourteen days with Mt. Diablo coal, of which it consumed in that time three hundred and seven thousand three hundred and eighty pounds. She then ran fourteen days with Seattle coal, doing the same work as before, with a consumption of two hundred and sixty-one thousand two hundred and eleven pounds. According to this test, the value of the Seattle coal, that of the Mt. Diablo coal being unity, is 1.177, a result which agrees very closely with that obtained for these two coals from the experiments of Mr. Elliot.

The foregoing are all the definite results of comparative experiments of this kind upon any considerable practical working scale which I have been able to obtain.

It is well known that with certain coals the Central Pacific Railroad Company has made such experiments with care and upon an extended scale, for its own benefit, upon its locomotives as well as upon its steamboats. But I regret to say that, upon applying to the company for the definite results of these experiments, with the permission to make them public, I met with a polite but positive refusal, upon the ground that, as this company is the largest single purchaser of coal upon this coast, they did not deem it right for them to place upon record any tests or experiments from which, perhaps, a standard might be established to the detriment of some and the benefit of others who are dealers in coal.

I confess that I am not able myself to understand the full force of this objection, well knowing, as I do, the fact that all the heavier dealers in coal in San Francisco already know the relative values of the different coals for steam with a sufficiently close approximation to the truth to guide their action in the matter of prices, or of anything else relating to the market, as fully and as surely as any mere publication of the exact figures could do it.

But, though I could obtain no definite information from the railroad company itself, I may state that I have good reason to believe that some of their recent experiments with Seattle coal on locomotives have shown a difference, as between it and the Mount Diablo, of over thirty per cent in favor of the Seattle coal. How reliable these experiments may be, of course I do not know; but if reliable tests have furnished this result, then from the results already given of the tests at the Spring Valley Waterworks and on the ferryboat, it would seem to follow, either that the Seattle coal compares more favorably with Mount Diablo for locomotive use than it does for use under stationary boilers and on steamboats, or else that there has been within the last two years a very marked improvement in the quality of the coal furnished to this market from the Seattle mines. It is claimed by the owners of the mines that the latter is the fact; and it is worth noticing that the two analyses above given, the one by Mr. Hanks in 1875, and the other by Falkenau and Hanks in 1868, seem to add probability to this claim, as the later analysis shows only 6.70 per cent of water against 11.66 per cent in the earlier one.

If, now, we collect in tabular form the results of all the above experi-

ments, we shall have the following table of relative values of different coals for steam, the value of the Mount Diablo coal being assumed as unity:

RELATIVE VALUES OF DIFFERENT COALS FOR STEAM.

Kind of Coal.	Value.	Remarks.
Mount Diablo	1.000	
Seattle	1.171	Experiments at Spring Valley Waterworks.
Sydney	1.502	Experiments at Spring Valley Waterworks.
Welsh	1.472	Experiments at Spring Valley Waterworks.
Bellingham Bay	1.148	Experiments at Spring Valley Waterworks.
Nanaimo	1.277	Experiments at Spring Valley Waterworks.
Anthracite	1.546	Experiments at Spring Valley Waterworks.
Wellington	1.407	Experiments at Spring Valley Waterworks.
Nanaimo	1.335	Experiments at Garratt's foundry.
Wellington	1.295	Experiments at Garratt's foundry.
Seattle	1.177	Experiment on ferryboat.
Seattle	1.330	Probable results of tests on C. P. R. R.

The cause of the difference between the results obtained at the waterworks and those at Garratt's foundry for the relative values of the Seattle, Nanaimo, and Wellington coals, I cannot explain, but merely give the figures as I obtained them.

Conclusion.

To him who has carefully read the foregoing pages, it will be apparent that the days of the old Mount Diablo mines are numbered. Even within the few months which have elapsed since the preparation of this volume was begun, the operations of these mines have been considerably curtailed. At the time of the strike against a reduction of wages there in October, 1876, the Pittsburg Company ceased operations upon the Clark bed entirely, and withdrew the pump from their lowest level on that bed. Since that time their mining has been confined entirely to the "Little Vein," in the old Eureka ground, and to the Black Diamond bed. It is not unlikely that they may hereafter resume their work upon the Clark bed for a sufficient length of time to enable them to extract the coal which yet remains above their present lowest level. But it is not probable that they will ever sink their works any deeper upon this bed.

At about the first of December, 1876, the Union Mine was finally closed, its pumps and machinery taken out, and the working of the mine entirely abandoned. It is not probable that the Union Company will ever resume work.

Of the old companies, therefore, there now remain actually at work only the Pittsburg and the Black Diamond Companies. The mines of the Black Diamond Company are in much better condition, generally, than that of the Pittsburg, and will undoubtedly hold out considerably longer, a fact which is largely due to the sound management of their able mining Superintendent, Mr. Morgan Morgans. But, in the face of their necessarily heavy and constantly increasing costs of mining, they too must, ere many years, succumb to the better quality, and eventually the lower costs of production and transportation of the coals of Washington Territory and British Columbia.

Whether the hitherto unworked eastern portion of the Mount Diablo coal field can, under existing circumstances, be worked at a profit, remains to be seen. But outside of this, there is no other coal field yet known in

California which gives reasonable promise of being able to compete, to any considerable extent, with the northern mines.

Neither is it probable that the mines of Coos Bay (the only ones yet worked in Oregon), will be able many years longer to continue work at a profit in the face of the Washington Territory coals. For though the distance from San Francisco to Coos Bay is only about one half as great as it is to Puget Sound, yet the shallow and often unsafe character of the bar at Coos Bay, the small size of the vessels which can go there at all, and the uncertainties which oftentimes attend the movements of even these small vessels, are such that the rates of freight from Coos Bay have generally ranged as high, and have often been actually higher than they were from Seattle; while it is more than probable that a company which owned and ran its own suitable steam colliers could transport coal from Seattle to San Francisco at a considerably lower cost per ton than they could do from Coos Bay. Moreover, the cost of mining at Coos Bay is greater than it is at Seattle; while at the same time the quality of the Coos Bay coal, for domestic purposes as well as for steam, is decidedly inferior to that of the more northern coals.

It is unquestionably to the mines of Washington Territory and of British Columbia that this Pacific Coast must look hereafter, both for its chief domestic and its nearest and most reliable foreign supplies of that indispensable necessity of all civilized communities—a good article of coal.

1887.

Mr. P. B. Cornwall has been kind enough to furnish the following statement of the quantities of coal shipped from the Black Diamond Coal Company's mines at Nortonville, Contra Costa County, since 1876:

In 1877	75,094 tons.
In 1878	63,373 tons.
In 1879	71,451 tons.
In 1880	80,130 tons.
In 1881	60,173 tons.
In 1882	61,722 tons.
In 1883	55,965 tons.
In 1884	52,529 tons.
In 1885	6,262 tons.

In 1884 and 1885 there was for many months a glut of coal in the California markets, and the best of foreign coals were very cheap. The Black Diamond Company, therefore, then decided to close down their Mount Diablo mines, and accordingly they stopped work there early in 1885, removed all their extensive plant of machinery and materials, allowed the mines to fill up with water, and took away their railroad track from the mines to the landing; thus verifying the prediction made ten years ago by the present writer, that "ere many years," those mines "must succumb to the better quality, and eventually the lower costs of production and transportation of the coals of Washington Territory and British Columbia."

Previous to the stoppage of work here, the great vertical shaft of the Black Diamond Company was sunk nearly to the Black Diamond bed, or to a total depth of about seven hundred and fifty feet, and a large extent of ground was worked out at this level from the Black Diamond bed. But Mr. Cornwall states that the "Clark Vein" is still solid and untouched everywhere below the level of what was known ten years ago as the Lower Mount Hope Gangway.

There is, therefore, a vast amount of coal yet remaining in these mines, which, though it cannot be profitably mined under existing present con-

ditions, can and probably will be made available at some time in the future, whenever a foreign war or any other great emergency shall arise to render coal scarce and high for any considerable length of time in California.

Mr. M. W. Belshaw, who has worked the old "Empire," and the "Central" (or Stewart) mines extensively for the past ten years, states that during this period he has been turning out a general average of about three thousand tons per month, the several monthly products ranging all the way from two thousand to four thousand tons.

Both of these mines, however, are now pretty nearly worked out down to the "Nine Hundred Feet Level." This means nine hundred feet measured on the dip of the beds below their datum line, which is at or somewhere near the surface of the ground. On this lowest, or nine hundred feet level, they have a large quantity of water to handle, and under present conditions, it will not pay them to go deeper there.

Immediately southeast of the old "Empire Claim," however, there is a piece of ground which Messrs. Belshaw & Co. have recently purchased, and which contains a good many thousand tons of coal which they can extract at a profit.

The following statement from Mr. J. E. Nourse, Weigher for the Pittsburg Coal Company at Pittsburg Landing, is here added:

Coal shipments from the Somersville mines from January 1, 1873, to December 1, 1887:

Year.	Tons.	Lbs.
1873	60,739	1,090
1874	73,548	2,190
1875	59,994	930
1876	45,801	1,020
1877	26,784	1,560
1878	37,501	840
1879	32,475	680
1880	51,009	2,100
1881	29,609	2,080
1882	15,634	1,790
1883	17,176	830
1884	5,636	1,220
1885	11,938	1,540
1886	18,712	100
1887	18,455	1,720
	505,019	1,750

December 6, 1887.

J. E. NOURSE, Weigher.

It is deemed well to reprint here from the "San Francisco Journal of Commerce" its annual review of the coal trade for the year 1886, as follows:

Annual Review for 1886.

The supply of coal in San Francisco from all sources for 1886 most undoubtedly falls short of the demand. That demand increases yearly at the rate of 5 per cent, so that the total imports for the present year should be a round million tons. As, however, up to December first they were only in round figures eight hundred and seventy-five thousand tons, it is evident that by the close of the year they cannot exceed nine hundred and fifty thousand tons. This, therefore, leaves us short fifty thousand tons, which shortage has to be drawn from stocks on hand, depleting them to that extent. It should, therefore, make the market have an upward tendency,

and this it most certainly has. The cause of this shortage was twofold: the strike in Washington Territory early in the year, and the peculiar condition of the freight market. Owing to these causes combined there has, during the past six months, been a material change in the price of imported foreign coals. This is, as already intimated, due: first, to the depressed condition of the wheat market; second, to the unprecedentedly low rates of freight to Europe; third, because the prospects of Australian wheat, wool, and other products have enabled English ship owners to realize better business from Australia than from California. With coal at low rates here, and wheat at low rates from here to Europe, the quantity of Australian and English coal for shipment to this market is less than known for several years. This, of course, will make an extra demand for coast coals which is already making its effect felt. The collieries are all preparing to meet the augmented demand by the free chartering of vessels. This has given rise to some slight rise in rates of freight. Previously rates from the northern collieries have been lower than ever before known. This has arisen from the large number of vessels coming to Puget Sound from China in ballast and with tea cargoes. Rates of freight on coal to San Francisco have been as low as $1 75 per ton. Besides this, numbers of wheat vessels preferred to make a trip or two in coal at low rates while waiting for a possible improvement in wheat charters. The condition of the market is strong. The outlook at present is better than it has been in twelve months.

IMPORTS OF FOREIGN COAL FOR TWENTY-ONE YEARS.

Years.	British Columbia.		Great Britain.		Australia.		Chile.		Other Countries.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1866	9,066	$46,887	8,220	$34,091	51,551	$144,659	2,200	$9,312	1,048	$5,222	72,085	$240,171
1867	14,653	166,793	4,564	22,391	25,165	81,773	11,136	44,440	5,591	24,197	61,109	239,594
1868	22,790	123,214	28,859	94,260	31,701	89,056	8,213	34,473	742	3,348	91,563	341,003
1869	16,779	97,784	13,446	38,983	70,319	159,796			433	1,607	100,977	298,170
1870	13,979	84,457	28,673	79,142	84,251	182,753	7,350	34,244	2,612	21,155	136,865	401,751
1871	16,004	92,093	55,478	152,013	38,751	84,125	4,179	21,972	345	998	114,757	351,201
1872	23,574	133,772	28,059	131,234	110,111	255,465	2,644	10,823	1,826	12,234	166,214	543,528
1873	32,327	178,504	57,156	281,715	91,100	310,401	400	2,255	1,519	10,429	182,502	783,304
1874	62,672	324,362	46,932	199,447	107,010	403,860			1,252	7,950	217,866	935,119
1875	62,110	326,588	65,932	228,188	139,164	522,792			183	1,138	267,100	1,078,706
1876	101,572	522,555	116,836	317,927	129,097	502,102	3,203	9,799	696	3,840	351,404	1,356,223
1877	98,842	456,004	*76,750	193,214	92,768	345,943	7,259	†26,731			‡275,619	1,021,892
1878	143,241	607,427	46,722	120,935	137,684	517,186			9	31	327,656	1,245,579
1879	165,102	643,380	31,911	74,899	77,522	318,613					274,535	1,036,890
1880	178,334	638,990	61,779	103,019	51,137	195,620					291,150	937,629
1881	153,541	488,641	267,940	593,298	125,780	351,373					547,261	1,483,312
1882	144,816	496,692	163,643	403,881	165,353	487,905					473,812	1,388,478
1883	117,822	423,831	155,102	363,676	150,318	447,407			6,895	8,655	430,137	1,243,569
1884	254,202	1,039,997	138,295	322,238	153,192	457,967			790	2,611	546,479	1,822,813
1885	217,848	854,799	182,998	476,058	167,567	413,164					568,413	1,744,021
1886	183,056	787,419	166,937	311,202	198,081	604,394					548,074	1,703,015

* Exclusive of some cargoes arriving and not clearing, and some not entered.
† Exclusive of some not entered.
‡ Exclusive of several cargoes not entered.

EASTERN.

Year.	Cumberland.	Anthracite.	Total.
1860	4,069	34,683	39,032
1861	2,157	26,960	39,032
1862	3,354	36,648	40,002
1863	3,816	36,657	40,483
1864	5,661	44,676	50,393
1865	2,516	25,759	28,285
1866	2,891	19,787	22,678
1867	7,987	62,507	70,104
1868	2,427	31,413	34,340
1869	9,774	33,316	43,590
1870	3,402	22,548	31,940
1871	5,667	11,480	17,147
1872	8,151	14,709	22,860
1873	8,857	18,285	27,152
1874	16,172	12,671	28,843
1875	14,100	12,026	30,126
1876	11,711	12,661	25,373
1877	11,500	22,306	32,806
1878	9,900	11,737	93,937
1879	1,778	22,795	24,543
1880	20,720	19,185	39,903
1881	13,620	13,123	26,745
1882	15,874	24,304	39,273
1883	16,555	76,725	43,200
1884	25,047	13,486	33,533
1885	8,035	21,000	29,035
1886	12,243	5,115	17,358

PACIFIC COAST.

Year.	Seattle.	Bellingham Bay.	Coos Bay.	Rocky Mountain.	Mount Diablo.
1860		5,488	3,143		
1861		8,136	4,628		6,620
1862		11,245	2,815		23,402
1863		9,175	1,186		43,198
1864		9,736	1,300		37,458
1865		12,270	1,615		60,540
1866		11,475	1,753		84,024
1867		8,615	5,235		109,990
1868		13,886	10,594		133,839
1869		20,552	14,758		148,722
1870		13,976	2,171		129,760
1871	4,546	20,924	26,731		133,484
1872	14,120	4,100	30,321	1,809	163,322
1873	13,572	11,210	37,898	1,904	170,000
1874	7,848	17,499	48,581	363	205,256
1875	62,119	10,440	29,078	53	142,808
1876	86,047	21,280	39,965	194	108,846
1877	101,088	10,475	30,296	134	97,674
1878	113,005	2,720	29,023	20	122,411
1879	136,012	Carbon	43,297		134,739
1880	120,473	Hill.	36,905	55	160,400
1881	145,173	18,357	20,621		114,000
1882	146,181	54,120	15,215		102,356
1883	163,986	137,420	24,525		76,162
1884	174,131	136,896	25,217		77,485
1885	170,938	157,241	27,699		5,920
1886	174,561	144,579	42,168		25,000

TOTAL PACIFIC COAST.

Year.	Tons.	Year.	Tons.
1861	19,384	1874	279,547
1862	37,462	1875	244,498
1863	53,559	1876	256,332
1864	48,494	1877	239,667
1865	74,425	1878	267,179
1866	97,232	1879	314,048
1867	123,840	1880	318,833
1868	158,299	1881	298,151
1869	184,032	1882	317,872
1870	145,907	1883	403,093
1871	185,685	1884	413,729
1872	213,672	1885	361,798
1873	234,584	1886	386,308

GRAND TOTALS.

Year.	Tons.	Year.	Tons.
1861	112,579	1874	526,248
1862	118,346	1875	541,724
1863	124,459	1876	632,122
1864	145,508	1877	564,012
1865	165,722	1878	622,094
1866	192,015	1879	613,289
1867	255,053	1880	643,116
1868	328,599	1881	872,155
1869	314,713	1882	830,992
1870	284,632	1883	876,510
1871	317,589	1884	987,941
1872	403,752	1885	959,246
1873	454,238	1886	1,011,867

In his annual report for 1886, J. W. Harrison has the following: The importation of coal this year foots up larger than ever before, clearly demonstrating an increase of consumption for domestic and manufacturing purposes; there can be no stronger indicator of prosperity than this article, hence there is good cause for congratulation. Prices have ruled low all through the year; in fact the average has been the lowest known, and it is questionable if it will ever be repeated. The fallacious figures published of our grain crop of 1886 induced tonnage to seek this port, anticipating freights outward from here would reach fancy figures, hence coal was carried at nominal rates; besides the Australian fleet had no choice, they were forced to come, the Australian harvest proved a failure (wheat was shipped from here), and ship owners chartered for coal at eight shillings per ton from Newcastle, and five shillings from Sydney. Present rates from Australia are fully four shillings higher.

The extremely low figures of foreign coal have worked a hardship on our coast collieries, as with very few exceptions their monthly workings showed a loss for the first nine months of the year; the recent improvement will help their annual showing, which at best will be a poor one. The East Wellington colliery, after a struggle of several years, reports a six-foot vein, and will henceforth become a regular shipper.

The following table of prices will show the monthly fluctuations of foreign coals for "spot" cargoes. The average price is given for each month:

Months.	Australian.	English Steam.	Scotch Splint.	West Hartley.
January	$5 87	$5 75	$6 75	$7 50
February	5 55	5 55	6 75	7 50
March	5 50	5 50	6 75	7 50
April	5 75	5 62	6 75	7 50
May	5 75	5 62	6 75	7 50
June	5 75	5 62	6 75	7 50
July	5 75	5 62	6 62	7 25
August	5 87	5 62	6 50	7 00
September	5 87	5 62	6 50	7 00
October	6 12	5 75	6 50	7 00
November	6 20	5 90	6 50	7 00
December	6 25	6 12½	6 50	7 00

The various sources from which we have derived supplies are as follows:

	1884—Tons.	1885—Tons.	1886—Tons.
British Columbia (Wellington and Nanaimo)	291,546	224,298	252,819
Australia	190,497	206,751	287,293
English and Welsh	108,808	170,656	160,869
Scotch	21,143	29,228	19,795
Eastern (Cumberland and Anthracite)	38,124	29,834	19,517
Seattle	125,000	75,112	57,552
Carbon Hill	122,060	157,251	124,527
Green River, Cedar River, Mount Diablo	77,485	71,615	90,664
Renton, Newport, and South Prairie	60,413	67,604	73,654
Totals	1,035,076	1,023,339	1,087,690

The arrivals at Wilmington and San Diego are computed in the above figures.

As our manufacturing interests are enlarging annually, and the population increasing, we can safely estimate an increase of coal consumption in 1887, and it is to be hoped that the northern collieries will find a market for their products which will leave them remunerative returns.

I. Steuart, in his annual report, says: The foreign coal trade, during the year now ended, has been, on the whole, satisfactory to those engaged in it, from the fact that a lower level of values was fully established and recognized by importers and buyers. The low price of Australian coal, while affecting prices of all kinds of foreign coal, was caused by an excess of tonnage from there seeking this port, and loading coal at low rates of freight, there being no wheat to load in consequence of the failure of the Australian crops, while the crop prospects here at that time were very good, with every appearance of the likelihood of there being a large amount of wheat for export from here. It may, therefore, be safe to take the prices prevailing during the earlier part of 1886 as a guide to the lowest figures Australian coal is ever likely to touch in future, while the small list of tonnage from Australia now on the way and loading there for this port, with the probable large amount of wheat Australia will have for export in the season, may point to prices during the earlier part of 1887 being comparatively high, and should our own season be a dry one, will probably be marked as a guide to extreme figures for foreign coal.

Coal during the year was obtained from the undernoted sources:

	1886—Tons.	1885—Tons.
Australian	209,028	168,138
English and Welsh	104,556	157,196
Scotch	16,550	21,322
Eastern Anthracite and Cumberland	15,929	27,084
British Columbia	176,618	206,207
Seattle, Green River, and Cedar River	106,325	130,024
Carbon Hill	174,551	152,200
South Prairie	32,682	51,459
Coos Bay	41,000	27,800
Totals	877,239	941,430

The following table shows the highest and lowest price per cargo of various kinds of foreign coal:

	1886.		1885.	
	Highest.	Lowest.	Highest.	Lowest.
Australian Wallsend	\$6 45	\$5 50	\$6 75	\$5 50
Cardiff	6 50	6 00	7 25	6 50
West Hartley	7 25	6 87½	7 75	7 37½
Brymbo	6 00	5 30	6 70	6 25
Scotch Splint	6 50	6 12½	6 87½	6 37½

The receipts from the coast mines have not been as heavy as their proprietors may have wished, as the low prices prevailing for foreign coal during the greater part of the year necessitated quotations which left little profit for coast mine owners.

Coke.

The importations this year foot up twenty-six thousand two hundred and ninety-three tons, as against twenty thousand six hundred and eleven tons in 1885, and ten thousand six hundred and ninety-five tons in 1884, thus showing a steady increase annually. A few years since the coke consumption was confined entirely to foundrymen; now it is distributed among ore smelters in Arizona and Utah, as well as locally, its freedom from sulphur making it specially advantageous for their purpose.

The following information concerning the coals of California was gathered by Mr. Goodyear in the course of his field-work in the summer and autumn of 1887:

Fresno County.

On Section 14, T. 22 S., R. 13 E., M. D. M., where the barometer read two thousand six hundred and thirty feet, the Southern Pacific Railroad Company are now prospecting a heavy bed of coal.

Tunnel No. 1 has been driven about five hundred feet on this bed, which here strikes about S. 65° E., magnetic, and dips 80° to 85° or more northeasterly.

There are several small breaks or faults within the length of this tunnel. For a distance of about one hundred and fifty feet in from the mouth of the tunnel, and to a depth of at least forty or fifty feet beneath the surface, the coal of this bed has actually been *burned out in place* at some time in

the past, leaving a red ash mixed with large quantities of thoroughly melted cinder or slag.

About one fourth of a mile farther up the cañon, is Tunnel No. 2, about three hundred and fifty feet long in a direction N. 85° E., magnetic, on the same bed, which here also stands nearly vertical, dipping about 85° towards the north.

The bed itself is from twelve to fourteen feet thick, and most of it seems to be tolerably clean coal, which strongly resembles the appearance of that which used to come from the "Black Diamond bed" of the old Mount Diablo mines. In both tunnels the hanging wall, *i. e.*, the wall on the north or northeast side of the bed, has the appearance of what may be called a sandstone conglomerate, *i. e.*, a conglomerate in which the pebbles and bowlders themselves consist of unaltered sandstone. But no such appearance as this is visible in the rock at the few points where I saw it cropping on the surface of the ground, and it is a matter of some little doubt in my mind whether this rock is really a conglomerate, or whether it is simply a sandstone in which incipient metamorphism has developed nodules of all sizes and shapes which give it the appearance above described. In either case, it is a tolerably strong rock, and will make a fair wall for a mine. The foot-wall, on the other hand, is a very soft, clay-rock, which is full of "slickensides," and will make a very bad and dangerous wall for a bed which stands so nearly vertical as this one does.

At a point about one thousand feet down the cañon from "Tunnel No. 1," the same coal bed dips only about 32° towards the north. They have here gone down about ninety feet with a slope, and found the bed so far considerably rolling and irregular, and are getting considerable water. The foot-wall here also is a soft, nasty clay-rock. Between the coal bed and the serpentines and jaspers, which are not far off on the south, there is a heavy bed of metamorphic, fine-grained, blocky sandstone.

Whether this mine can ever be made to pay is, in my judgment, to say the least, a very doubtful question. Heavy as the bed is, and good as the quality of the coal seems to be, there are nevertheless great disadvantages connected with it:

First—The dip of the bed, standing nearly vertical as it does in the two tunnels, is anything but desirable for the cheap working of a heavy coal bed.

Second—This position of the bed renders the bad character of the foot-wall a far more difficult and dangerous thing to cope with in mining than it might otherwise be.

Third—There is plenty of evidence that the rocks here are greatly disturbed and faulted, and it is not likely that the bed will be found continuous for any considerable distance with any uniform strike and dip.

Fourth—The locality is in the heart of the mountains, two thousand six hundred feet above the sea; and, speaking not too roughly, it may be said to be to-day nearly fifty miles from anywhere.

Mr. J. Richards, the present Superintendent of this mine, states that he owns in the Livermore Valley a coal mine in which there are six feet of good coal, which he worked down to water level, when his means to go deeper failed him. I think this mine must be the one referred to as the "Summit" Coal Mine on page 73 of my book on "The Coal Mines of the Western Coast," but am not quite sure, never having seen the mine myself. We spent the night of October twenty-first at the house of Mr. James Frame, in a cañon about thirty miles from Huron, where the barometer read one thousand five hundred feet.

On the twenty-second, visited the coal mine of Messrs. Robinson & Raw-

lins, which is situated on the west half of Section 26, T. 20 S., R. 14 E., M. D. M. At this locality the barometer read one thousand and sixty feet. It is about nineteen miles from Huron.

The lower tunnel starts in the cañon near the boarding house. The upper tunnel is about one quarter of a mile further up the cañon, and runs in on the vein about five hundred feet. The strike of the vein is about N. 35° W., magnetic, and the dip will average about 30° to the northeast. The thickness averages about three and a half feet of clean coal. Immediately beneath the coal in this tunnel there is about a foot of very thin-bedded brown shale, below which comes heavy-bedded sandstone. The roof immediately over the coal is slate, black and hard. Of this there is from two to three feet. Over that comes sand rock. The coal resembles in appearance that of the Clark Vein at Mount Diablo, but is softer, and slacks much more on exposure to the air. Barometer at mouth of upper tunnel read one thousand two hundred and thirty feet. There are no faults nor breaks of any kind within the length of this tunnel. Between the two tunnels the rocks on the surface in the gulch are at one or two points more or less disturbed. The lower tunnel cuts across the strata. It first runs perfectly straight S. 50° W. for one thousand feet, the strata for this distance being perfectly regular without fault or break of any kind. The total length of the tunnel is some fourteen hundred or fifteen hundred feet; but for the last four hundred or five hundred feet the strata are more or less irregular and the tunnel somewhat crooked. The strike and dip for the first one thousand feet are about the same as in the upper tunnel. In the lower tunnel, at a point about one hundred and sixty-five feet from its mouth, they cut through a stratum of sandy shales, about eight feet thick, saturated with bitumen. The same shales outcrop in the bank alongside the road a little above the mouth of the tunnel. A little maltha also oozes from them. In the last four hundred or five hundred feet of the lower tunnel they passed through some half dozen thin streaks of coal, the largest being about one foot thick. The ground in there is also soft and bad.

On Section 22, of the same township, Mr. William Strader, of Huron, informs me that he also has a coal mine. A gulch here runs easterly, and a tunnel has been driven here about four hundred feet in a southeasterly direction, having coal all the way except for the first thirty or forty feet. But the coal is much broken and varies greatly in thickness, the maximum being about three and a half feet. On the opposite side of the gulch, a tunnel runs northwesterly thirty-five feet in coal, which averages three and a half feet thick. Two slopes have also been sunk about thirty feet, in each of which the coal is regular, and three and a half feet thick.

San Diego County.

The new little town of Elsinore is situated on the eastern shore of a lake of the same name, which lies at the eastern foot of the Sierra de Santa Ana, in the northwestern part of the county, and not far from one thousand four hundred feet above the sea. In summer the lake has no outlet; but in times of heavy rains it discharges its surplus waters into Temecula Cañon, a branch of Temescal Creek, which runs to the Santa Ana River. At the time of my visit (June 18, 1887) the lake was about seven miles long and three miles wide. Its maximum depth in the northwestern part is said to exceed three hundred feet. But the greater portion of it is very shallow, and it varies greatly in area and depth at different seasons and in different

years, depending upon the quantity of rain. In the later summer, or whenever it gets low, it is slightly salty and alkaline.

At Elsinore there is a fine, warm, sulphur spring, with a temperature of about 117° F., and a good bath-house over it. About half a mile northwest of this spring, there is in the valley another warm sulphur spring; and within fifty feet of it, a pure, cold, fresh water spring.

In the vicinity of Elsinore, I also visited the coal field referred to in the Fourth Annual Report of the State Mineralogist, page 269, as being "four and a half miles from Laguna Station, on the California Southern Railroad;" a later analysis of a sample of the coal from here being also published in the Sixth Annual Report, part 1, page 117.

The name of the railroad station has been changed from "Laguna" to "Elsinore," though it is distant one or two miles from the new village of Elsinore proper.

The mines are about four and half miles northwesterly from the station in an air line, or about six miles by the wagon road.

At the time of my visit (June, 1887) the following parties owned the lands:

Messrs. Dolbeer & Hoff owned:

The whole of Sec. 27	640 acres.
The fractional south ½ of Sec. 26	240 acres.
On the N.W. ¼ of Sec. 35	20 acres.
On the northern corner of the Laguna Ranch	100 acres.
Total	1,000 acres.

Messrs. Collier & Cheney owned:

The E. ½ of Sec. 22	320 acres.
The E. ½ of the S.W. ¼ of Sec. 22	80 acres.
The N. ½ of the N.W. ¼ of Sec. 26	80 acres.
Total	480 acres.

All these lands are in T. 5 S., R. 5 W., S. B. M.

On the S.W. ¼ of Sec. 26, the new town of "Terra Cotta" has been laid out, and there also is Dolbeer & Hoff's coal mine, where a shaft has been sunk eighty feet deep, which, according to the statement of Mr. H. T. Blackwell, the mining Superintendent, passed through the following strata, beginning at the surface:

17	feet—Red clay.
8	feet—Red sandy clay.
2	feet—White sand.
3	feet—Sandy fossil formation.
10	feet—Jointy, sandy clay.
12	feet—Sand and clay mixed with fossils.
16	feet—White sand.
2	feet—Sand and bowlders.
4	feet—Fire clay.
½	foot—Slate.
1	foot—Shale.
½	foot—Slate.
2	feet—Coal.
1	foot—Fire clay.
½	foot—Coal.
½	foot—Black shale and sand to the bottom.
80	

They have started southwesterly from the foot of this shaft, and driven some two hundred or three hundred feet, going down somewhat on the dip. The strike is northwesterly and the dip southwesterly, about the same as

in the Cheney Mine. And though they had only two feet six inches of coal at the bottom of the shaft, Mr. Blackwell tells me they now (June eighteenth) have about four feet six inches of coal in the face of the drift. Here, also, they have encountered a little water. The roof in this drift is very weak and unsafe, and requires close timbering and planking. The coal also, at the time of my visit, was very soft and dirty, contained large quantities of iron pyrites, and clinkered badly.

Overlying the coal in the Dolbeer & Hoff Mine there is a bed of bituminous shale which, at the time of my visit, showed a thickness of about eighteen inches. This shale somewhat resembles the Australian shale in appearance, is rich in volatile bituminous matter, and may prove of value in the manufacture of illuminating gas.

At the Cheney Mine a tunnel is driven in a northerly direction about three hundred and fifty feet into the hill, exposing a bed of very clean coal five and one half feet thick, with only a single soft streak of dirt, about one inch thick, in the middle of the bed, which facilitates mining. Immediately over the coal there is about two and one half feet of mixed clay and sand rock, above which lies another stratum of from two to two and one half feet of coal, which, however, is not so pure as that in the lower bed. The strike at this locality is about N. 70° W., magnetic, and the dip about 5° to the southwest.

About five or six hundred feet northwest of here, a second tunnel starts in a direction about due east, magnetic, and runs three or four hundred feet into the hill, curving gradually around towards the northeast, and at last strikes a large fault which consists of a downthrow of some thirty or forty feet towards the northeast. The mouth of this tunnel appears to be outside of the edge of the coal basin; for, though the strata are continuous and undisturbed until the above mentioned fault is reached, yet no carbonaceous matter whatever is visible in the shales at the mouth of the tunnel. But as we advance into the hill it soon begins to show itself and thence gradually increases in quantity until, at a point between two and three hundred feet from the mouth of the tunnel, the shale is completely replaced by the same bed of clean coal which is exposed in the other tunnel. About half a mile north of here there is another opening which I did not visit, but in which, I am told, that the bed shows the same characteristics as in the two tunnels just described. It ranges from four to eight feet in thickness, but will average fully five and a half feet. The overlying rock here is rather a coarse-grained sandstone, not very hard, but nevertheless strong enough to make a moderately good roof.

The hills are not very high, and the covering above the coal is probably nowhere more than one hundred to one hundred and fifty feet deep. The formation is either very recent Tertiary or perhaps Post-Tertiary in age, and the coal basin is probably a local deposit covering no very great extent of country. What its actual area may be can only be determined by further explorations under ground. But there is in any case enough of it here to last for many years. The coal itself at this locality looks very clean, is bright black in color, and when first taken out of the mine is quite handsome, though rather soft. It, however, contains considerable water, and on exposure to the air it rapidly cracks and crumbles so badly that it cannot be burned to advantage except upon grates specially adapted to its use. It kindles easily, burns freely with a long smoky flame, does not coke nor clinker, and leaves a fine pulverulent and very white ash. It can be used for domestic purposes as well as for steam, and will be of much value in this portion of the State where fuel is scarce and high.

An analysis of the bituminous shale from Dolbeer & Hoff's Mine made by Mr. Thomas Price, May 13, 1887, gave the following result:

Water	2.65 per cent.
Volatile bituminous matter	44.25 per cent.
Fixed carbon	7.40 per cent.
Ash	45.70 per cent.
	100.00
Sulphur	3.43 per cent.

An analysis of the coal from the same mine, also made by Mr. Price in March, 1887, gave the following:

Water	17.50 per cent.
Volatile bituminous matter	41.00 per cent.
Fixed carbon	28.65 per cent.
Ash	12.85 per cent.
	100.00
Sulphur	5.6 per cent.

An analysis of the coal from the Cheney Mine, made by Dr. W. D. Johnston, Chemist of the Bureau, in June, 1887, gave:

Water	19.00 per cent.
Volatile matters	46.50 per cent.
Fixed carbon	21.90 per cent.
Ash	12.60 per cent.
	100.00

I think the sample of coal from Dolbeer & Hoff's Mine, of which the analysis by Mr. Price is given above, must have been a picked specimen, for the analysis shows larger percentages, both of fixed and volatile carbonaceous matters, together with a considerably smaller percentage of ash, than I should judge the average product to contain.

About three hundred feet south of the mouth of the first tunnel above described on the Cheney property, in Section 22, there is exposed a bank of very pure clay of considerable thickness. At the time of my visit they were manufacturing brick here, and were laying plans for a large establishment for the manufacture of various kinds of pottery, terra cotta, etc.

There is said to be rich gold quartz in the southeast part of the Temescal Range of mountains, some five or six miles north of Elsinore, and some of the specimens which I saw in Mr. Hoff's store at Elsinore were literally wired through and through with gold.

Mr. Hoff also has an asbestus mine some seven miles southeasterly from Elsinore, where he says there is a vein of it three feet thick, out of which he is now making fire-proof paint, as well as coverings for steam pipes, steam boilers, etc.

On the peninsula between San Diego Bay and the ocean a well has been sunk four hundred and thirty-five feet deep without success in finding artesian water. The strata passed through are said to have been almost exclusively loose sand, with only occasional thin layers of sandstone and clay shale.

In the bluffs at Ocean Beach, near San Diego, recent strata lie nearly horizontal. At this locality, also, a hole dug five or six feet deep in the sands of the beach, not more than three hundred or four hundred feet back from the edge of the surf and only about five feet above tide, gives an abundance of good, fresh water, while a quarter of a mile further back

a well sunk seventy-five feet deep in the hill yields only brackish alkaline water. The fresh water in the beach sands probably finds its way there from a distance of some miles back in the country by percolation through the sands underlying the dry bed of the San Diego River, whose mouth is close at hand.

The following analyses were recently made by Dr. W. D. Johnston, Chemist of the Bureau, of Southern California coals collected by Mr. Goodyear during the past summer.

Coal mine, Section 14, T. 22 S., R. 13 E., Mount Diablo meridian:

Water	4.10 per cent.
Volatile carbonaceous matter	43.40 per cent.
Fixed carbon	40.25 per cent.
Ash	12.25 per cent.
	100.00
Coke, firm and compact	52¼ per cent.

Robinson & Rawlins:

Water	15.50 per cent.
Volatile carbonaceous matter	40.00 per cent.
Fixed carbon	29.50 per cent.
Ash	15.00 per cent.
	100.00

Does not coke.

Dolbeer & Hoff, near Elsinore. Poorest coal:

Water	9.00 per cent.
Volatile carbonaceous matter	38.50 per cent.
Fixed carbon	19.25 per cent.
Ash	34.25 per cent.
	100.00

Best piece:

Water	15.4 per cent.
Volatile carbonaceous matter	43.6 per cent.
Fixed carbon	27.9 per cent.
Ash	13.1 per cent.
	100.0

Does not coke.

Face of gangway:

Water	16.25 per cent.
Volatile carbonaceous matter	43.75 per cent.
Fixed carbon	28.15 per cent.
Ash	11.85 per cent.
	100.00

NATURAL GAS.

To the State Mineralogist, William Irelan, Jr.:

Dear Sir: Herewith please find my report on the geological field-work carried out by me under your instructions in the sections where I was especially delegated.

Very respectfully,

ADOLPH H. WEBER.

NATURAL GAS.

Owing to the almost entire absence of good coal in this State within easy reach of the markets, and the high price of the imported article, the discovery of natural gas within the limits of our State has been very welcome. The discoveries have become quite numerous, particularly since the successful application of natural gas as a fuel in Pittsburg and other places.

Most prominent among the localities investigated are the ones in the neighborhood of Stockton, the gas, however, being under a low pressure and accompanied by a copious flow of water.

In the following the various localities are given according to the counties:

Nevada County.

Near Boca, when the snow is crusted and an inverted funnel thrust into the snow, gas enough can be collected in certain localities to give a flame. In the ice company's reservoir at Prosser Creek, near Boca, gas bubbles are rising continually.

Santa Cruz County.

The disastrous explosions which took place in the tunnels of the South Pacific Coast Railroad at Highland some years ago were due to natura gas.

Sonoma County.

As early as the end of the fifties, the occurrence of natural gas was known at Geyserville, for it interfered seriously with the digging of wells. The gas came into the wells in such quantity as to compel the men to quit work. Many a well was abandoned on this account and filled up again. In the marsh lands, on Sonoma Creek, gas has been found in the artesian wells. At one or more wells the gas is collected and used for domestic purposes.

San Joaquin County.

In the vicinity of Stockton a large number of artesian wells have been sunk.

The first of these, the celebrated Court House Well, was bored during the years 1854–58, reaching a depth of one thousand or one thousand and two feet.

At five hundred and sixty feet a stream of water was struck, but lacked five feet of reaching the surface; at nine hundred and thirteen feet the water rose seven feet above the surface, and at one thousand feet depth, the water rose nine feet above the city grade. The water coming from the bottom of the well brought up with it considerable gas, exciting great curiosity, particularly as the gas would burn. The flow of the well is still very large (one hundred and fifty thousand gallons in twenty-four hours); but the piping has rusted and become leaky. The waters from this well now supply the swimming baths, having a temperature of 80° F.—warm enough for a delightful bath.

In 1879, Charles D. Gibbs read a paper before the California Academy of Sciences, giving a history of this well and the results obtained.

The following is a list of the artesian wells bored in the immediate neighborhood of Stockton:

Name of Well.	Distance and Direction from Stockton.	Depth, in Feet.	Flow, in Gallons, in 24 Hours.
Old Court House	In Stockton	1,003	150,000
Paper Mill, No. 1	½ mile west	597	100,000
Paper Mill, No. 2	½ mile west	365	
Old Waterworks	In the city	1,076	225,000
Geo. Ladd	2 miles southeast	976	450,000
Zignego & Podesto	⅛ mile northeast	1,045	225,000
Dr. Grattan	4 miles northeast	1,010	450,000
S. Sanguinetti	2¼ miles northeast	1,100	225,000
New Waterworks, No. 1	In the city	1,013	300,000
New Waterworks, No. 2	In the city	1,005	300,000
New Waterworks, No. 3	In the city	1,011	300,000
McDougald	2 miles south	976	600,000
Cutler Salmon	7 miles southeast	{ 1,000 1,250 }	375,000
Gen. Williams	14 miles west	1,435	150,000
S. Strait	3 miles southeast	1,080	300,000
State Insane Asylum	In the city	1,091	225,000
Pope Salmon	9 miles southeast	1,404	
Crown Mills	In the city	1,220	350,000
Haas	In the city	*3,000	
Standard, No. 1	½ mile south	*2,000	
Standard, No. 2	1,300 feet west of No. 1	*1,100	

The well on Cutler Salmon's place, in Castoria Township, was bored in 1883, during the months of July and August, to a total depth of one thousand two hundred and fifty feet. Seven-inch piping was put down to eight hundred and forty-two feet, and four-inch to a depth of one thousand one hundred and forty feet; the latter pipe reaches the surface.

The water from the larger pipe is excellent, while that issuing from the smaller is brackish. However, the latter carries a large amount of gas, while the former contains but little. The gas is collected in a tank and used for lighting, heating, and cooking in the house. The supply of gas is ample, not one half of it being caught, and that is more than sufficient for the purposes mentioned.

At the Old Waterworks the water carried enough gas to cushion the pumps, and consequently had to be thrown into a pond to allow the gas to escape, before the water could be forced into the city mains. The water is good. This well has a nine-inch casing nine hundred and sixty or nine hundred and seventy feet deep.

At the New Waterworks all three wells carry gas—No. 1 most, and No. 3 least. The gas from Well No. 1 is passed over gasoline to enrich it in carbon, and is used to light the engine-room. Altogether eleven ordinary burners are in use, with no reserve, the gas being used directly as it comes from the well. The gas from Wells No.'s 2 and 3 is not used at present; these wells are seven inches in diameter, while No. 1 is eight inches. The water from all three is good.

The McDougald Well, bored in 1883, two miles south of Stockton, has a seven-inch casing, nine hundred and seventy-six feet deep, the well itself having been carried about fifty feet further. This well produces a large

* Approximate. Accurate figures for these wells cannot be given; the reasons will be given later on.

amount of gas. By actual measurement it registered between seven thousand and eight thousand cubic feet of gas per twenty-four hours, under the average meter pressure. The gas is used in Mr. McDougald's house, but only a small part of the flow is actually used; the rest escapes into the air. The water is poor.

About fourteen miles west of Stockton, on Roberts Island, General Williams had a well sunk in 1883 to a total depth of one thousand four hundred and thirty-five feet. The seven-inch pipe reached one thousand feet; the six-inch, one thousand two hundred and fifty feet, and the five-inch pipe to the bottom. Quite a copious flow of gas was struck; it was sufficient to supply either the house or the boilers of the engine, but not enough for both. The water was very poor, in fact got worse the greater the depth, and the well had to be closed to keep the water off the land, to prevent the latter from being ruined.

In 1884 Pope Salmon put down a well to a depth of one thousand four hundred and four feet (seven-inch pipe to seven hundred feet, and five-inch to bottom), from which he obtains gas sufficient for domestic purposes. The water is fair and plentiful.

Other wells, with the exception of the Crown Mills, the Haas, and the Standard, furnish little or no gas, though their water supply is ample. Strange to say, these are often bored to the same depth, and are situated in close proximity to others that do produce gas. A further and more complete investigation will doubtless throw some light on the subject.

The occurrence of the natural gas in some quantity finally began to attract the attention of capitalists. The great success in the use of natural gas in the East spurred them up to develop the deposits of gas in California. In December, 1885, the Standard Gaslight and Fuel Company was incorporated at Merced, with the object of developing natural gas in the San Joaquin Valley, beginning operations in the spring of 1886 at Stockton.

In the summer of the same year the California Well Company was organized at Stockton for a similar purpose, and began operations immediately (August, 1886), by sinking the Haas well, named after Jerome Haas, the Superintendent.

The Crown Mills well has been bored during the past summer with an initial diameter of nine inches. At the end of October a depth of one thousand two hundred and twenty feet had been reached. A large flow of gas was struck at this depth, the flames reaching a height of eight or nine feet. Careful measurements of the gas and water flow made by Mayor Welsh, show that the gas flow from the well is eighteen thousand cubic feet in twenty-four hours, while the water flow is two hundred and fifty-five gallons per minute, or about three hundred and fifty thousand gallons per twenty-four hours. Mr. Welsh says the mill requires six thousand cubic feet of gas each week for lighting, and he expects to light the mill with the natural gas and use the surplus as fuel. The well will be bored deeper, as it is thought a better flow of gas can be had two or three hundred feet deeper.

The gas is not being used as yet (December, 1887), as its introduction either as a fuel or as light requires many a change to be made in the plant on hand, or a new one to be set up.

The Haas well, bored by Jerome Haas for the California Well Company, is situated on the northern bank of Mormon Slough, nearly opposite the paper mill. The gas flow from this well was very large many months ago. However, the boring has been continued to a greater depth, but just how deep no one knows except those connected with the company. The well

was started with a diameter of twelve inches and continued to one thousand and twenty-three feet, of which nine hundred and eighty-two feet were piped; then a ten-inch pipe was inserted and carried to a depth of over one thousand three hundred feet. As was indicated by other wells sunk in and near Stockton, a strong flow of good water, with some gas, was tapped by the twelve-inch pipe. The ten-inch pipe pierced a stream of brackish water with considerable gas. This was also expected from previous experience. Both pipes reached to the surface, and the space between was cemented at the top. Then the ten-inch pipe was perforated a few feet down, thus uniting the flow of both pipes. The gas was collected in a box and amply sufficed to keep up steam in the boiler running the drills and pumps.

Inside of the ten-inch pipe there is one of eight and a half inches, also reaching to the surface, but how deep it penetrates the earth is unknown. This much, however, is true; that the diameter of the well was again reduced to seven and one fourth inches, and it was being sunk in May, 1887, with that diameter, with further reductions to six-inch, five-inch, and four-inch still in view. The temperature of the water flowing from this well, 92° F., gives currency to the belief that a depth of fully three thousand feet has been reached.

The company has furnished the following statement of measurements of the flow: "Most of the water-bearing strata pierced beyond a depth of one thousand feet, carry more or less gas. A total of eighty-one thousand to eighty-two thousand cubic feet of gas per twenty-four hours has been measured by means of a twelve-foot receiver; a large amount of gas, however, escapes in the water, of which the measured flow is one thousand five hundred gallons per minute."

The right to lay pipes throughout the city has been granted to the company, and encouraged by the large flow of gas from their well they intend to compete with the local gas company for the contract to light the City of Stockton for the next ten years. It is the purpose of the company to enrich the natural gas with some vapor rich in carbon so as to give the flame a greater candle power.

The well (No. 1) of the Standard Gaslight and Fuel Company is situated on the north side of the French Camp road, just south of the city limits of Stockton. Their other well, No. 2, is about one thousand three hundred feet to the west of No. 1, on the levee, and is claimed to be about one thousand feet deep. The company assert that their principal well (No. 1) is a good deal over two thousand feet deep, but decline to give accurate figures.

The well was started with a diameter of ten inches; this was subsequently reduced to eight inches, and in May, 1887, six-inch pipe was in use. But at what depths these reductions were found necessary is unknown. Similarly the quantity of gas and the depth at which it was struck is unknown.

Marin County.

It is said that Cornelius Murray has discovered natural gas on his ranch at Nicasio, and has already bonded the right to San Francisco capitalists.

Contra Costa County.

Natural gas bubbles up in the mineral springs at Byron.

Lake County.

Gas is found near Kelseyville, and has been used to make steam.

Solano County.

Natural gas is found back of Davisville in the foothills.

Sacramento County.

On the Norris Ranch, the property of Messrs. Haggin & Tevis, on the American River, a few miles from Sacramento, some gas has been found.

Tehama County.

Eight miles east of Red Bluff are found the Tuscan Springs. The waters are medicinal, but with the water quite an amount of gas escapes. It is the intention of the owner to collect the gas and light the house with it, but he hesitates to sink a well for fear he might tap several of his springs and thus mix them.

Mendocino County.

Some gas has been found at Caspar Creek. Hiram Willits, at Willits, bored a well for water seventy-five feet deep, but instead of obtaining water he struck a small flow of gas.

Humboldt County.

The fact that natural gas occurs at Petrolia and neighborhood, in this county, has been mentioned under the subject of "Petroleum."

The wells on Oil Creek, sunk in 1866, have since then given off gas together with brackish water, continuously.

The Davis Well, on Bear River, struck quite a strong flow of gas at a depth of about nine hundred feet. The flow of gas continues to the present day. When once ignited it will burn with a flame a few feet high, all through the summer, until the first of the winter storms extinguishes it. In the spring and early summer, it is a regular thing for travelers to stop and light it. No use is made of it.

In the well on Mr. Gear's place, on Bear River, some gas occurred; however, the well has caved in now.

Along the Upper Mattole the presence of gas is very pronounced. All three wells sunk there struck gas. It also rises from the bottom of the Mattole River for several hundred yards. On Roscoe Creek a shaft had to be abandoned on account of the gas.

In the middle section of the oil district natural gas was found in several of the wells, but mostly in small amounts.

On James Gough's place in Sec. 8, of T. 2 S., R. 2 W., a strong flow of gas issues from a well sunk there in 1866–67. The flow continues unabated to the present day, producing, when ignited, a flame three or four feet high. Unluckily the well is close to the barn and consequently a source of anxiety to the owner. At a slight expense the gas could be piped to the house and used for fuel and light.

On the Union Claim on the Lower North Fork of the Mattole, the wells pierced a bed of sandstone, four to five feet thick, at a depth of thirty-five feet, carrying some petroleum and plenty of gas.

Near Petrolia, in the Jeffrey Well, since caved in, gas was found nearly all the time while sinking.

A natural gas spring is found on the left bank of Bear River between the Davis Well and the road.

When cutting the tunnel (one thousand nine hundred and forty feet

long), on the Eel River and Eureka Railroad, in Secs. 8 and 17, T. 3 N., R. 1 W., great difficulty was experienced on account of the inflammable gas flowing from the strata pierced.

At Freshwater, a ten-inch well was drilled for water to a depth of two hundred feet. At eighty feet, gas enough for a jet was struck. This is on the edge of Humboldt Bay, in marshy ground.

In the low swampy grounds to the west and southwest of Eureka, along the edge of the bay, gas bubbles up through the water in a number of places.

In August, 1886, a six-inch well was started for the Ricks Waterworks, in Eureka, on the south side of Fourth Street, between G and H Streets. At the end of July, 1887, after one hundred working days, a depth of six hundred and seventy-seven feet had been reached. At a depth of six hundred and fifty to six hundred and sixty-five feet gas was struck sufficient for two lights.

Humboldt County.

Coal has been known to exist at various localities in Humboldt County for over twenty years. The abundance of wood throughout the county has, however, prevented any development of the coal veins. The magnificent redwood forests have as yet been scarcely touched, and outside of the redwood belt there is no lack of oak and other trees, furnishing the best firewood. With refuse wood from the mills at about $1 a cord at Eureka, and given away or burnt elsewhere to dispose of it, and cordwood at $3, coal is used by very few. As return freights for the lumber vessels are always in demand, the amount of coal actually needed at Eureka and the immediate neighborhood is readily supplied at cheap rates.

Nevertheless, the time will come when Humboldt's stately forests will be leveled and the available wood burnt. It is then that the more concentrated mineral fuel will be in demand; and the coal deposits will receive due attention.

The blacksmiths at various interior points have taken out coal sufficient for their purposes, at the cost of considerable time and labor, rather than pay the enormous freight charges on the imported coal.

The advent of a railroad, either from the Sacramento Valley or from Ukiah into Humboldt County, will necessarily add a great stimulus to the development of the coal veins.

The finds of coal in the county have been quite numerous, particularly in the southern half. Among the localities in which mineral fuel has been found in Humboldt County may be mentioned:

*1. Eureka.
*2. On Maple Creek, three miles from Mad River.
*3. Two miles north of Arcata; half mile from the Jolly Giant Mill.
*4. On the Upper Mattole, on Mr. Thomas Rudolph's place, T. 3 S., R. 1 W., Sections 11, 12, 13, and 14.
5. On the Main Eel River, two miles below Alder Point, on Wm. Wood's place.
*6. On Jacoby Creek.
*7. On Larribee Creek, T. 1 S., R. 4 E., Section 26; also Sections 2, 3, 10, and 11.
8. Across the Eel River from Eagle Prairie, in the bluff.
9. On the Van Dusen, three or four miles above Bridgeville.
10. On the Van Dusen, opposite the Cooper place.
*11. On the South Fork of Eel River, one mile north of Garberville.
*12. On Bear Creek, one mile east of Garberville.
*13. On Panther Gulch. } Tributaries of the East Branch of the South Fork of
*14. On Buckmountain Gulch. } Eel River.
*15. On the East Branch of the South Fork of Eel River, on the Ray Ranch, T. 4 S., R. 4 E., Sections 32, 33, 34, and 27.
16. On the Hoopa Indian Reservation.

*The localities marked thus were visited in July, 1887, by the writer.

The mineral fuel found in Eureka occurs within the city limits, near Twelfth and L streets. The succession of the strata from the surface down is as follows:

1. Sand, 16 feet.
2. Lignite, 18 to 24 inches, average 22 inches.
3. Clay, 4 feet.
4. Lignite, 1 foot.
5. Clay, 3 feet.
6. Clay with shells, 1 foot.
7. Clay, 11 feet and deeper.

The clay is an excellent material for brick-making, particularly when mixed with some sand. The sand from the top layer is used for this purpose. It was the establishment of a brickyard that caused the opening of these beds. The lignite was thrown away for a long time as useless, waste material, before it was recognized.

The lignite is a very poor, soft material, soaked with water, in reality being only a somewhat consolidated peat. It must be dried like peat before it can be used. The only use that has been made of it has been to help burn the bricks made of the clay and sand found above and below the lignite. The strata are very nearly horizontal.

2. The first United States patent taken out for coal lands in the county, or, in fact, in the Humboldt Land District, was issued May 5, 1887, to John C. Preston for the following land: S.W. ¼ of S.W. ¼ of S. 20, and S.W. ¼ of N.W. ¼ of S. 29, T. 5 N., R. 3 E., H. M., together eighty acres.

The lignite, for such is the material occurring on the land, is of a brown color, woody texture, and devoid of luster. Locally it was pronounced petrified wood, experienced woodmen claiming to recognize madrona, redwood, and other trees still growing in the neighborhood. Be that as it may, a woody texture is easily discernible in the lignite.

The lignite has a strike of N. 45° W., and a dip of 45° to the N.E., magnetic. There are two beds, separated by three to three and a half feet of rock; the upper being one foot and the lower two feet thick. Both the roof and floor are sandstone. The two beds could easily be mined together, and the material between them used to fill up the old workings. A shaft was sunk and a tunnel driven on this bed of lignite, but both have caved in.

There are evidences of another bed of lignite further up Maple Creek, as proved by drift, etc., but it was not examined. The lignite described above crosses Maple Creek about three miles from Mad River. The Arcata and North Fork Railroad is only six or eight miles from the mouth of Maple Creek. The composition of the lignite is—

Water	11.75 per cent.
Volatile carbonaceous matter	46.80 per cent.
Fixed carbon (does not coke)	29.60 per cent.
Ash	11.85 per cent.
	100.00

The ash is a yellowish gray powder.

3. It is claimed that lignite occurs about two miles north of Arcata, and a half mile from the Jolly Giant Mill. A tunnel was driven on the bed years ago; the tunnel has now caved, and, as the bed is nowhere exposed, nothing definite can be said about this locality.

4. On the Upper Mattole, on Mr. Thomas Rudolph's place, T. 3 S., R. 1 W., Section 12, several small beds of coal have been noticed six and eight inches thick. One was found in digging a well, others in the im-

mediate neighborhood, on Sections 11, 12, 13, 14. Nothing has been done to prospect this locality. The strata have a small dip to the north.

5. On the Main Eel River, two miles below Alder Point, on William Wood's ranch, the existence of an eight-inch bed of coal has been known for some years. Beyond taking out a few sacks of the coal for blacksmith work, nothing has been done.

6. On Jacoby Creek, about a half mile from the end of the lumber railroad, and four miles from Humboldt Bay, a half-inch seam of coal occurs in the sandstone, mentioned under the head of Building Stones. Several beds of black shale were taken to be coal by the workmen. This section can be easily and thoroughly prospected, as the strata are nearly vertical and the exposures quite numerous.

7. On Larribee Creek, T. 1 S., R. 4 E., Section 26, H. M., on the ranch of B. Curless, small pieces of coal were found; but on closer examination the rock proved to be breccia made up of small fragments of shale, sandstone, etc. Amongst these were the specimens of coal found, showing the former existence of some small beds, but now crushed and mixed with fragments of the other rocks. In Sections 2, 3, 10, 11, of the same township, coal is also reported; also in Section 21.

8. The occurrence of lignite in the bluff on Eel River, opposite Eagle Prairie, has been known some time, but it has not been developed.

9. The existence of coal in the Van Duzen Creek, three or four miles above Bridgeville, has been noted.

10. Also on the Van Duzen, opposite the Cooper place, coal has been reported. Also on Yager Creek, one mile above Hydesville.

11. On the South Fork of Eel River, one mile north of Garberville, seams of coal, a few inches thick, are found in heavy beds of sandstone and conglomerate. Practically, only traces found here.

12. On Bear Creek, emptying into the South Fork, near Garberville; about one mile east of the town, a few inches of coal have been found with slate in the sandstone.

13. On Panther Gulch, one of the tributaries of the East Branch of the South Fork of Eel River, traces of coal have been found.

14. On Buckmountain Gulch, another of the tributaries of the East Branch, a bed of coal crops a couple of feet thick. Several sackfuls have been taken from here and used in the forge, and pronounced excellent. It is possibly a continuation of the next.

15. On the Ray Ranch, T. 4 S., R. 4 E., six or seven miles south of Garberville, on the East Branch of the South Fork of Eel River, a bed of coal has been found of good quality, three or four feet thick. The strike is a little west of south, and the dip is 50° to 60° W., magnetic.

This coal cokes well; its composition is:

Water	10.75	per cent.
Volatile carbonaceous matter	48.50	per cent.
Fixed carbon (firm coke)	38.30	per cent.
Ash	2.45	per cent.
	100.00	

The ash is a light yellow powder.

The coal has good luster, and, as far as examined, is nearly free from pyrites. Some work has been done in this locality. Possibly this is the same bed that crops out in Buckmountain Gulch, to the north of the Ray Ranch.

16. Lignite has been found on the Hoopa Valley Indian Reservation.

Trinity County.

1. At Poison Camp, not far from the western county line in T. 3 S., R. 6 E., H. M., Section 33, a fair sized bed of lignite is found. It is from four to four and a half feet thick. The strike is N. 20° W., and the dip 20° N.E., magnetic. The roof is clay, while the floor is a hard sandstone.

The composition of the lignite is:

Water	16.50 per cent.
Volatile carbonaceous matter	44.15 per cent.
Fixed carbon (does not coke)	34.10 per cent.
Ash	5.25 per cent.
	100.00

The ash is a light gray powder.

The lignite is a true, typical one, brown color, no luster, and even showing some woody structure.

2. About three hundred yards further down the creek (Sandstone Gulch) another bed of three feet thickness is found. It is overlaid with two feet of pipe clay, and underlaid by sandstone. This bed is exposed for some distance along the creek and thins out to twenty inches at one point. The strike and dip were not recorded. There is a possibility that this is a section of the bed described above, having been carried down into the creek by a slide. But the distance, and the bedding of the other rocks, speak rather in favor of its being an independent bed.

3. On Bluff Creek, five or six miles beyond Poison Camp (eastward), some coal has been found, but mixed with slate.

4. Near the middle of Hettenchon Valley, near Mr. D. Wilburn's place, coal is reported, but mixed with shale.

5. Near the head of Hay Fork, a branch of the South Fork of the Trinity River, and on several places along the course of Hay Fork, beds of coal are exposed, but seem to be broken up considerably. They are alleged to be a continuation of the beds occurring on the Trinity River, near Cox's Bar.

6. At Cox's Bar, on Trinity River, the placer miners have uncovered several beds of coal. It seems the auriferous gravels lay directly upon the coal in a number of places. This locality has furnished the coal for all the blacksmiths in that part of the county for a number of years.

Messrs. Newton, Bankhead & Co. have filed seven or eight claims on a coal vein on Trinity Mountain, to the north of the South Fork of Trinity River. On the divide between the Little and Big French Creeks several beds of coal are said to be exposed.

Tehama County.

On Elder Creek, about thirty miles west and south of Red Bluff, the existence of coal has been noted. On the North Fork seams a few inches thick imbedded in sandstone show themselves in two places, really mere traces. On the South Fork an eight-inch bed is said to occur.

Mendocino County.

1. Coal has been found on the Albion River, about eight miles from the coast, in cutting a lumber road. The bed is two feet thick; it has not disappeared under a slide.

2. In Russian Gulch, two and a half miles from Mendocino City, coal

has been noticed; it is only a small vein. It is in T. 17 N., R. 17 W., M. D. M., either in S.W. ¼ of S. 18 or in N.W. ¼ of S. 19.

3. Traces of coal occur near Ferguson's Cove, five miles south of Point Arena, T. 12 N., R. 16 W.

4. Near the head of the Garcia River, about twelve miles from Point Arena and near the east line of T. 12 N., R. 13 W., coal has been seen.

5. A five-foot bed of coal is reported as cropping out about ten or eleven miles up the South Fork of Ten-Mile River, in T. 19 N., R. 16 W.

6. Coal in traces has been noticed at the mouth of Salmon Creek.

7. On the stage road from Cahto to Westport, about three miles from Cahto, coal has for some time been known to exist.

8. In the Doolan Cañon, three miles west of Ukiah, coal was reported. It turns out to be shale, with fine, very thin seams of coal.

9. The coal found on Ackerman Creek, about three miles northwest of Ukiah, proves to be a small, irregular vein, in sandstone, an inch or so in thickness.

10. Four miles south of Little Lake a very small, irregular seam of coal has been found in conglomerate. The seams are pockety.

The coal occurring on the Middle Fork of Eel River has been described by Mr. W. A. Goodyear, in his report. However, the following additional facts were noted:

The metamorphism and silicification extend to the coal itself, as is proven by the occurrence of highly silicified petrifactions, in the shape of tree stumps, etc., in the coal itself. Moreover, the bed of coal extends across the river to the north side, and not further, being cut by a fault running northeast and southwest.

About two hundred yards east, up the river, the strata, consisting of shales and sandstones, have a strike of N. 15° W., and a dip of 48° E., magnetic, indicating the existence of another fault.

To the south of the river the shales can be traced to the top of the ridge, about a mile distant from the river. Here the coal again crops out, and seems to have separated into two beds. The shales accompanying the coal can be traced a mile further south.

At the top of the ridge, a few hundred feet west of the point mentioned where the coal is found, a bed of limestone, six to eight feet thick, crops out on a spur, with a dip of 20° to 30° to the northeast.

It is said that the coal crops out on the North Fork of Eel River, but this statement has not been verified.

Sonoma County.

Indications of coal were found in the Santa Rosa Valley, on Mark West Creek, a few miles from Santa Rosa. A shaft was sunk to prospect the locality, and several beds, of varying thickness, were cut, but they all proved of such poor quality and carried such a high percentage of ash that the work was abandoned.

Colusa County.

Several small beds of coal are known to exist on Sulphur Creek, in the southwestern part of the county.

Shasta County.

In the east central part of Shasta County there is found a belt of sedimentary rocks, fifteen to twenty miles in width, and over thirty miles in length, north and south. These sedimentary rocks consist in the main of

sandstones, shales, and limestones; they lie in a nearly horizontal position, having a slight dip in different directions in various localities. Several faults, accompanied by some metamorphic rocks, traverse this belt. Among these strata a number of coal beds have been discovered, cropping out in the gulches and watercourses. The occurrence of the coal in the N.W. ¼ of Section 20, T. 33 N., R. 1 W., has been fully described by Mr. W. A. Goodyear in his report.

In the S.W. ¼ of S. 28, T. 33 N., R. 1 W., a small bed of coal about eighteen inches thick has been discovered inclosed in two layers of clay. The coal, as far as can be seen, is nearly free from slate; it has a slight dip to the west.

A small vein of coal was noticed in the creek bed in the S.E. ¼ of Section 29 of the same township. It is over a foot thick but full of slate.

In Section 7 there is an outcrop of slate, with very little coal close to the road.

In the northern tier of Sections 1, 2, 3, 4, and 5 of T. 33 N., R. 1 W., a bed of coal six or seven feet thick crops out at many points. The upper section of this bed is only a manifold repetition of thin layers of coal and slate, while the lower two feet are coal not wholly free from slate. The roof is sandstone; the floor is pipe clay nearly thirty feet thick.

This same bed crops in one or two of the gulches in Sections 32, 33, and 34 of T. 34 N., R. 1 W.

An eight-foot bed of coal has been developed to some extent by a tunnel on Section 12 of T. 33 N., R. 2 W. The tunnel was driven into the hill a distance of fifty or sixty feet in 1876. The separate layers making up the bed are as follows:

	Ft.	In.
Slate and coal in alternate thin seams	3	6
Coal with some slate	1	0
Slate	0	9
Coal with gypsum on the surface	0	9
Clayey slate	1	3
Coal	1	0
Total	8	3

Recently the tunnel was cleaned out and a sample of the coal taken to Redding to be tried at the gas works.

Messrs. S. Hull, W. Beamis, Clay Taylor, and William C. Whiten, made an application for coal land on the following land: E. ½ of S. 11, and N. ½ of S. 14, T. 35 N., R. 1 W. No proof has yet been offered, though the application was made years ago. The coal found on the place indicated is mixed with slate, and dips at a rather high angle (for the neighborhood) showing that the beds have been displaced and disrupted by faults.

Another filing on the S.E. ¼ of S.E. ¼ of S. 29, S. ½ of S.W. ¼ of S. 28, N.E. ¼ of N.E. ¼ of S. 32, and N.W. ¼ of S. 33, T. 33 N., R. 1 W., though of long standing, was never proved upon. The only patented coal land in the district is the N. ½ of S. 20, T. 33 N., R. 1 W.

On Nelson Creek, T. 37 N., R. 1 E., there are several small beds of coal exposed in slides along the creek.

On Kosk Creek, T. 37 N., R. 1 W., S. 24, a heavy bed of coal is said to exist, though in October, 1887, its outcrop was covered by a slide, and could not be examined. Coal is also reported from near the head of Kosk Creek.

PETROLEUM AND ASPHALTUM.

NORTHERN CALIFORNIA.

PETROLEUM AND ASPHALTUM.

NORTHERN CALIFORNIA.

HUMBOLDT COUNTY.

The oil region of Humboldt County is the most northerly in the State, in fact, the only one north of the bay of San Francisco that has ever produced any oil. The existence of petroleum here was known to the Indians and to the white settlers—to the latter certainly as early as 1860. Small quantities of the crude petroleum were collected from time to time and used for medicinal purposes. The district is not producing any oil at present, so that the following sketch is more of a history than a description of an industry now in successful operation. Nevertheless, the district is the principal one of Northern California, and was among the earliest discovered and prospected; so that a short review of the doings of twenty years ago may not be amiss.

The region is found in the southwestern part of the county, to the west of Eel River, extending from the coast about twenty miles inland, covering parts of T. 1 N., R. 1, 2, and 3 W.; T. 1 S., R. 1, 2, and 3 W.; T. 2 S., R. 1, 2, and 3 W.; T. 3 S., R. 1 W.; also T. 1 S., R. 1 E., and T. 2 S., R. 2 E., all reckoned from the Humboldt meridian.

The district can be naturally divided into three sections: The first and northern is that along Bear River and Oil Creek, extending some ten miles inland from the coast. The second is four or five miles south of the first, and comprises the drainage areas of Davis and McNutt Creeks, Lower North Fork of the Mattole, and adjacent tributaries of the Mattole River. The third section lies to the southeast of the second, along the Upper Mattole, the Upper North Fork, and the South Fork of the Mattole. The first comprises an area of twelve to fifteen square miles, the second covers about thirty square miles, and the third nearly twenty square miles.

In the fall of 1864 J. W. Henderson procured samples and took them to San Francisco. Here he interested several capitalists in the oil field.

The oil industry in the East had recovered from the collapse in 1861 and 1862, due to reckless speculation and over-production, and capitalists were again investing. This renewed confidence in the future of the oil industry extended to the people of this coast. They began to hope that oil fields similar to those of Pennsylvania might be discovered in our State.

People flocked to the oil district in question from all parts of the country and coast. One discovery followed another; oil springs were found on Oil Creek, on Davis Creek, on the Lower North Fork of the Mattole, etc. A town was started at the junction of the Lower North Fork with the Mattole River and appropriately called "Petrolia."

The scenes of Pennsylvania were repeated over and over again. The district had, however, one great difficulty to contend with, and that was its transportation facilities. There were in general but two ways of reaching "Petrolia;" one by sea to Eureka and thence overland, and the other directly overland from the bay.

In the northern section of the district the surface indications were quite pronounced. A group of four or five wells were sunk on the right bank of

Oil Creek. One of them was started with four inches, reaching a depth of one hundred and twenty feet, and was then continued at three inches and carried to a depth of one hundred and seventy-six feet; a small amount of oil was obtained at this depth and plenty of gas. A second well of six-inch diameter was put down two hundred feet and then had to be abandoned on account of the gravel in which it stood. No oil was found in this well and but little gas. The others did not reach any considerable depth. These wells were not dry, but alkaline water flowed from them all with the gas bubbling through it. The flow of water and gas continues to this day.

On the left shore of Bear River, about three miles from the coast, Mr. Irwin Davis put down a well six inches in diameter over nine hundred feet. The well proved to be dry; however, a copious flow of natural gas was tapped, as will be mentioned further on.

The Fortuna Well is situated on the Webster place—T. 1 N., R. 1 W., S. 18, S.E. ¼ of S.W. ¼. It was six inches in diameter and was put down full six hundred feet, but was dry, a small amount of gas only being found.

On the Johnson farm, N.E. ¼ of N.E. ¼ S. 19, T. 1 N., R. 2 W., a well was sunk two hundred feet, but struck neither oil, gas, nor water.

A well was bored in 1865 on the Hawley farm, now Mr. Gear's place, on N.W. ¼ of S. 21, T. 1 N., R. 2 W. It reached a depth of two hundred feet, though only four inches in diameter. Nothing but gas was found.

Oil springs were found along the courses of the various tributaries of Bear River as far as ten miles inland from the coast. Also one or two miles south of the mouth of Bear River, near the coast. Thus in T. 1 N., R. 1 W., S. 17; N.W. ¼ N.E. ¼ S. 8, T. 1 N., R. 2 W.; also N.W. ¼ S. 9, T. 1 N., R. 2 W.; N.W. ¼ of S.E. ¼ S. 15, T. 1 N., R. 2 W.; S. 5, T. 1 N., R. 2 W., Humboldt meridian.

These springs were developed by means of trenches and shallow pits, allowing the oil to collect on the surface of the water and gathering it by means of skimming or absorption in blankets.

The total amount of oil produced by this section was very insignificant.

On the Upper Mattole, in that part of the district described above as the third section, but three wells were sunk.

The Fonner Well was put down by Mr. J. C. Fonner in 1866, on the south side of the river, in the N.W. ¼ of N.E. ¼ S. 33, T. 2 S., R. 1 W. It reached a depth of nearly three hundred feet, striking some gas, but no oil.

2. The Upper Mattole Oil Company in 1867 bored a five-inch well to a depth of over two hundred and fifty feet in the S.W. ¼ of S.W. ¼ S. 28, T. 2 S., R. 1 W., and struck a small flow of gas.

3. The third well was sunk in the same year under the superintendency of Dr. Pugh, on the S.E. ¼ of S.E. ¼ S. 28, T. 2 S., R. 1 W., three hundred feet deep, five inches in diameter, with same results.

There is an oil spring a little over two miles up the Upper North Fork of the Mattole. Another is on the South Fork, a mile and a half from the main river. On Roscoe Creek, about a mile from the Mattole, there is still another, on which a shaft was sunk thirty feet but abandoned on account of the gas. Traces of oil may also be discovered on the main river itself just below the mouth of the South Fork. This section has produced no oil at all.

In the central section of the district quite a large number of wells were sunk during the years 1865, 1866, 1867:

1. The Jeffrey Well was sunk on the right bank of the Lower North

Fork, about half a mile west of "Petrolia." It reached a depth of nine hundred feet. At four hundred feet a twenty-foot bed of sandstone was passed; above and below this the material was shale and blue clay. There was no oil found and but little gas. The first three hundred feet were cased with six-inch pipe. It took from June, 1865, to May, 1866, to sink the well.

2. The Davis Well was located half a mile north of the Jeffrey claim, and about one mile from town. It was started with seven inches; at fifty feet it was found necessary to reduce to six inches; this was carried to two hundred feet, when a five-inch pipe had to be substituted; this was carried down another hundred feet, when it was found that the well would stand without casing. The total depth reached by this well was between one thousand four hundred and one thousand five hundred feet. It was dry, only a small amount of gas being found; no water. This was the deepest well in the entire district. John Hunter, now of Grass Valley, was the Superintendent.

3. The Knowlton well was situated on the left bank of the Lower North Fork, in the N.E. ¼ of S. 26 of T. 1 S., R. 1 W., opposite the mouth of the North Fork of the Lower North Fork. It was shallow and dry.

4. To the north of the last, on the right bank and to the west of the North Fork of the North Fork, was the Brown & Knowles' Well. It was four and one half inches in diameter and three hundred feet deep, but neither oil, water, nor gas were struck.

5. About one mile up the North Fork of the North Fork, a San Francisco company went down two hundred and twenty feet unsuccessfully.

6. Across the creek, to the eastward of the Brown & Knowles' Well about half a mile, is the North Fork Well. It is a four-inch well and was put down one hundred and eighty feet. Its present depth is in the neighborhood of thirty feet. This was one of the productive wells, the total product being about thirty barrels. At the present time, although nearly filled up, one or two gallons can be collected every month.

7. In Section 30, T. 1 S., R. 1 W., on the left bank of the Lower North Fork of the Mattole, is the Union Claim, about one and one half miles further up the gulch than the last named. On this claim several wells were drilled, ranging in depth from thirty feet to one thousand feet. They passed through the following strata:

Shale and sandstone, 30 feet; depth, 30 feet.
Sandstone, 4-5 feet; depth 35 feet, carrying little oil, but plenty of gas.
Shale, 25 feet; depth, 60 feet.
Sandstone, 4 feet; depth, 64 feet; oil bearing.
Shale and blue clay, 26 feet; depth, 90 feet.
Sandstone, 5-6 feet; depth, 95 feet; oil bearing.
Shale and blue clay, 905 feet; depth, 1,000 feet; some gas.
Gravel, ? feet; depth, 1,003 feet; stopped here in the deep well.

The deep well was cased all the way, carrying three hundred feet of eight-inch pipe, four hundred feet of six-inch, and six hundred feet of five-inch pipe.

This claim produced considerable oil. About one hundred barrels were taken out and sent to San Francisco for trial. The wells had to be pumped, yielding at the rate of one barrel a day. All the oil was obtained either from sixty feet or ninety feet depth. The claim belonged to the Mattole Petroleum Company, in which Hon. L. Stanford was the principal owner. The wells were never tested to their full productive capacity, on account of the lack of storage facilities; quite an amount of oil was used on the spot for fuel and light. One of the wells is open to the present day, and

oil may be obtained in small quantities most any time, provided it rises above some tools left in the well; if it does not, a few buckets of water soon remedy the defect.

8. On the opposite bank, and about half a mile above the Union Claim, the Paragon Well was sunk, unsuccessfully, in 1865–66, under Thomas Duff as Superintendent.

9. Between the Union Claim and the North Fork Well, was the Kellogg Well—another dry hole.

10. Three miles to the northeast of "Petrolia," on Joel's Flat, the "Joel Flat" Well was located on John Walker's land, T. 1 S., R. 2 W., Sec. 23. This well was put down in 1867 to a depth of two hundred and thirty feet, with five-inch casing. At this depth the casing stuck, and the hole was continued without it; but only thirty feet more could be added on account of the sides caving in. The water was then pumped out, and on nearly reaching the bottom, oil issued from the pipe instead of water. All the available vessels in camp were soon filled and pumping discontinued. After a few days a tank had been put up, and the well was again opened; but it was found that the bottom of the well had caved. After several unsuccessful attempts to reach the oil-bearing zone again, the well was abandoned. The total amount of oil this well produced was about five barrels. The claim belonged to Scott & Parsons. Financial and other difficulties prevented a renewal of the enterprise.

In the neighborhood of the well small quantities of oil were obtained from pockets in the shale by sinking small holes and pits. About two hundred yards from the well there is a spring yielding a little oil. Messrs. George Noble and J. W. Henderson were Superintendents.

11. A company, with Mr. Muldrow at the head, bored several wells on McNutt Gulch. One of them, a six-inch, reached a depth of two hundred and fifty feet; two others, each four and a half inches only, reached one hundred feet. From the deepest one a few barrels of oil were obtained, but it was exhausted on pumping.

12. A well was drilled on the left bank of the Mattole River, directly south of "Petrolia." The venture was not successful.

13. In S. 8 of T. 2 S., R. 2 W., on James Gough's place, the drills penetrated the earth several hundred feet and quite a flow of gas was struck.

14. On Langdon Creek, one mile east of Petrolia, Minor K. Langdon located the Comet. No results obtained.

15. The Buckeye was on Conklin Creek, about two miles from the Mattole River. No oil.

16. About six miles from "Petrolia," up the Mattole, a party of Sacramento gentlemen bored a well and searched in vain for oil.

17. At Dudley's Mill, about a mile above the last named, another unlucky venture in the shape of a well left the owners poorer than they started out.

Several other wells were sunk in the district, but all record of them is lost; in fact, of quite a number of the wells enumerated above nothing remains to mark their spot save a few decaying timbers and an odd length or two of rusted pipe.

The existence of oil springs on Davis Creek and on McNutt Creek has already been noticed.

Having recounted at length the work done to develop the district, it now becomes necessary to review briefly the causes which led to its final abandonment.

Among these, the expensive transportation already alluded to above, was a great drawback from the very start and made itself specially felt during

the first year. The heavy machinery absolutely necessary for drilling was hauled in at an enormous cost, often crippling an enterprise at its beginning. Another reason was the drop in the price of crude petroleum, due to rich discoveries in Pennsylvania. During the year 1867 the price reached a second minimum, so that it was impossible for this coast (with the price of labor and machinery at a maximum) to compete with the East. Then, again, the failure to strike any flowing wells. But even if flowing wells had been tapped it would have cost more to bring the oil to market than it was worth, the transportation being expensive and tedious.

The chief reason was the following: The people interested in the oil lands had located them by the usual methods, as homesteads, or preëmptions, or by means of school warrants, soldiers' warrants, college scrip, etc. The land agent at Eureka had received these applications, made as they were, in good faith. When the oil was discovered in some quantity, the land agent reported the fact to the Commissioner at Washington, holding the title in abeyance pending the answer. Months passed ere the answer came, but work had been progressing steadily and considerable money was spent. The Union Wells had produced a quantity of oil and everything seemed prosperous. The answer came at last. It was an order to withdraw all the oil lands from sale and hold them as mineral land subject to entry as such. This order proved the death knell to the oil boom in Humboldt County. Special messengers were sent by the owners from San Francisco by way of the Sacramento Valley and Weaverville, with the order to stop work. This was a natural consequence. The investors, finding that they had no title, and were at the mercy of any person ready to jump their claim, rather chose to close down at once. Others, though they discontinued work, procured titles to their claims. Messrs. Scott, Parsons & Co. in this way obtained, it is said, over eighty thousand acres which they subsequently sold, reserving, however, the right to bore for oil. If the information received is correct, the Joel Flat Well was the first, of those in operation, to close down, the others following in a few days. The wells were plugged, and the machinery removed and sold.

The oil obtained in the Humboldt District is of a light brown color, quite limpid, with a slight green fluorescence.

During the course of the examination of the district in July, 1887, oil was obtained from a spring near Bear River, from the North Fork Well, and from the Union Well.

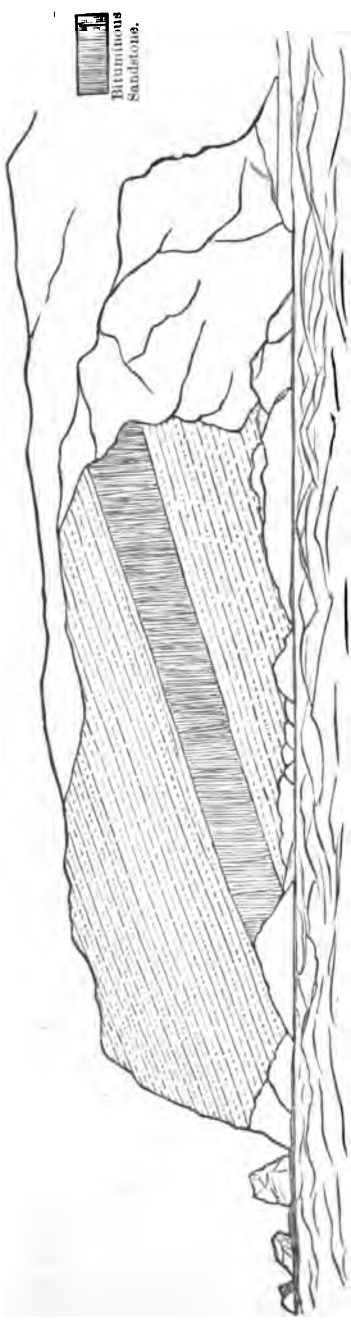
The oil-bearing rock is in all cases a fine-grained, porous sandstone, of a gray color. It is usually interbedded with thick strata of blue clayey shale. The following sketch gives a view of the bluffs on the coast south of Bear River, showing strata.

SKETCH OF THE BLUFFS ON THE COAST, SOUTH OF BEAR RIVER (THREE MILES).

A, B, C, D, E are faults. [EXPLANATION—By *faults* is meant a break in the continuance of the strata, and not an error in the sketch.]

In the interior, that is five to ten miles from the coast, the strata lie even more horizontal than shown in the sketch; especially along the Upper Mattole.

Mendocino County.



BLUFF ON THE NORTH SIDE OF POINT ARENA HARBOR (FROM THE WHARF). SHOWING THE BITUMINOUS SANDSTONE.

The Point Arena Petroleum Oil and Coal Mining Company was organized in January, 1864, and on February first had seven claims, each three hundred feet square, recorded at Ukiah.

Messrs. S. B. Campbell, David Beebe, T. S. Benoist, J. G. Campbell, F. H. Graves, Charles Koble, and H. K. Petygrove, were the original locators of these claims. Porter Oneal also took up a claim.

Several wells were sunk at Point Arena, but they struck no oil to amount to anything. At various places, however, beds of bituminous sandstone were developed. After failing to find any oil, the company next turned its attention to the production of oil from the bituminous sandstone by means of distillation. The preliminary experiments were very successful. A quantity of the material was sent to San Francisco and distilled. Although the oil produced was very good, its cost of production, and particularly the freightage from Point Arena, was too high to make the enterprise a profitable one, compelling the company to give up the project. The idea of utilizing the beds of bituminous sandstone lay dormant for a number of years. Only during the last few years the use of bituminous rock as a pavement for streets and sidewalks came into vogue.

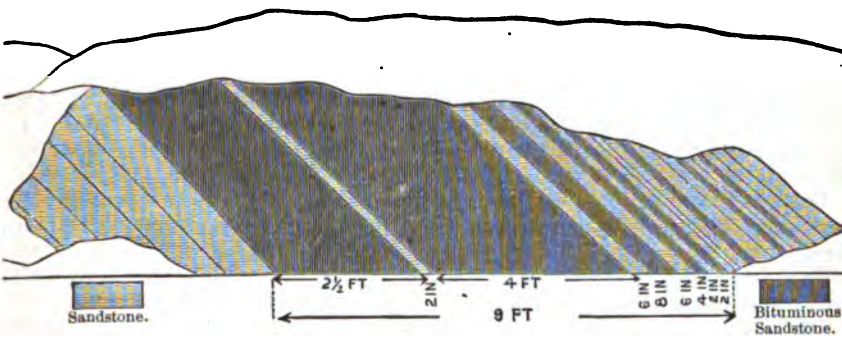
It was then recalled that enormous quantities of the material lay close at hand at Point Arena. The California Bituminous Paving Company was formed by Senator A. J. Meany, of Merced, Legrand Morse, Louis Morse, of Point Arena, and others. They bought up the rights to the asphalt rock in the neighborhood, and are now at work opening the quarries and getting ready for large shipments.

The largest bed is exposed in the Point Arena harbor. It is fully twenty feet thick, with a dip of 35° to the north, the strike being N. 10° to 20° W.

The foregoing is a sketch of the locality.

About a mile and a half north of the harbor is the other place where bituminous rock has been exposed by quarries. It is on the land of Mr. Porter Oneal, a short half mile from shore. There are two beds, called respectively the Upper and Lower Bed; the Lower Bed being to the eastward of the other.

The following is a sketch of the Lower Bed as exposed in August, 1887:



VIEW OF QUARRY ON LOWER LEDGE ONEAL CLAIM, POINT ARENA (LOOKING SOUTH).

The Lower Ledge has a total thickness of nine feet, of which, however, a foot and a half must be subtracted as the total of several thin beds of sandstone. The material from this Lower Ledge is of a brownish-black color, crumbles between the fingers quite easily, and on ignition leaves a residue of 93.2 per cent, showing but 6.8 per cent of volatile matter. The residue consists of a rather coarse quartz sand.

The section in the quarry exposing the Upper Ledge, about one hundred yards west of the one just described, is very similar to that of the Lower Ledge. The thickness is only eight feet, but there is scarcely any barren sandstone included. The two ledges differ somewhat in their dip and strike; the Upper has a dip of 48° or 50° to the southwest, and strike of N. 45° W.; while the Lower Ledge dips 38° S. and strikes N. 70° W.

The material from the Upper Ledge differs considerably from that of the Lower Ledge. It is a black, sticky, pliable mass, coarse-grained, but reunites under pressure. On ignition it leaves a residue of 88.8 per cent, showing 11.2 per cent volatile matter. The residue consists of quartz grains colored by oxide of iron.

The ledge in the harbor furnishes an article very similar to that of the Upper Ledge. The volatile matter amounts to 10.4 per cent, leaving 89.6 per cent residue of fine quartz grains. The mass has a brownish-black color, is soft and sticky, but crumbles under pressure.

Picked specimens have yielded as high as 15 per cent volatile matter.

The ledge at the harbor has been exposed, as can be readily seen from the sketch, to wind and weather, for many a year, so that its lack of cohesiveness and its low percentage of bituminous matter are readily explained. As soon as the surface material is removed, and the ledge developed, these properties will gradually improve.

The same may be true of the Lower Ledge, particularly when opened deeper below the surface than at present. The Upper Ledge furnishes a good material; its difference from that of the Lower Ledge is in part, at least, due to the fact that the former is inclosed in hard, dense sandstone, not very pervious to water and air.

At several other points in the neighborhood of Point Arena, bituminous

rock has been found, but apparently lacking not only in quality but also in quantity, as they have not been developed.

A slight indication of petroleum has been found on Caspar Creek when logging roads were being cut.

Oil springs were found and located in the hills east of Potter Valley, on May 22, 1865. The piece of land on which these springs occurred was to the east of a ranch owned by a Mr. Christopher, and only two hundred yards wide, but extending to the summit of the hills. G. W. Smith, P. W. Vann, and J. M. Cainer took up claims in this locality. (County Records, Ukiah.)

During the oil excitement on this coast in the years 1865, 1866, and 1867, the whole country was prospected for oil, and indications found and followed up in localities that are nowadays never mentioned in connection with oil.

Oil was found at Bolinas Bay, and the Bolinas Petroleum Company organized. Their works were located in the Arroya Honda, on the Bolinas Grant.

In Colusa County oil was found in various sections. In 1867 eight wells had been sunk, but with what result is not known.

Oil is also said to occur on "Sulphur Creek," not far from the county line. In 1865 Messrs. Rowe and Fleeson sank a well one mile below Simmons Spring, "Sulphur Creek." During the same year the Antelope Valley and the Pioneer Oil Company were operating in Colusa County.

In an article in "Mining and Scientific Press," April 15, 1865, it is stated that the "Colusa oil is light and sufficiently pure to burn just as it is taken up from the springs."

San Joaquin County.

According to newspaper accounts petroleum has been struck in two deep wells bored at Stockton during the present year.

Alameda County.

The Livermore Oil Company exhibited a sample of dark greenish-brown heavy petroleum from their well, seven miles southeast of Livermore, at the Mechanics' Fair, September, 1887.

BUILDING STONES.

BUILDING STONES.

We had hoped that the following communication from Hon. W. W. Morrow would have created sufficient enthusiasm to have induced the citizens of our State to at least have sent us a showing approaching a respectability. The within incorporated circular was scattered throughout the State, but with the exception of that which is incorporated in the article by Professor A. Wendell Jackson, the response has been immaterial, although promises have been plentiful:

"SAN FRANCISCO, April 4, 1887.

"*Hon.* WM. IRELAN, JR., *State Mineralogist, San Francisco, California:*

"DEAR SIR: I have heard it frequently stated that no discovery has yet been made on this coast of any good building stone other than that of the granite formation.

"I cannot believe this to be true, and I have always met such statements with the assertion that beds of good quality of sandstones were known, while quarries of basalt, and even rhyolite, have been developed.

"But it is claimed that our sandstones are not desirable, either in color or structure, and that the other stones are not convenient to market.

"In view of the fact that large, substantial buildings are about being erected in San Francisco and elsewhere on the coast, with every prospect that a season of building enterprise is upon us, I would recommend that your Bureau should give special attention just now to an investigation of building-stone quarries, or deposits, in this State. Full and reliable information upon this subject would, I think, aid very materially in securing the opening of such quarries and the erection of substantial buildings of stone for private as well as business purposes.

"The material for the new Post Office building will soon be a question of importance to the General Government, as well as the people of this community, and it would be of great advantage in securing liberal appropriations for the construction of the building, if we were able to show that we have a good variety of building stone of a durable quality and of sufficient quantity near enough to San Francisco to warrant us in saying that the erection of a substantial and imposing structure may be undertaken upon a moderate estimate for such building materials. This question has already been raised, and I think we should be prepared to meet it fully with all the information that can be obtained.

"I therefore commend this subject to your careful attention, in the hope that an examination be made in the direction indicated.

"Yours very truly,

"WM. W. MORROW."

CIRCULAR FROM THE STATE MINING BUREAU.

To Quarrymen, Architects, and Builders:

Wm. Irelan, Jr., State Mineralogist, with the coöperation of A. Wendell Jackson, Professor of Mineralogy, Petrography, and Economic Geology, in the State University, proposes to make an exhaustive investigation of

the building stones of the State, and to that end invites your active assistance in procuring the necessary material. The report will cover Mineralogical Description, based on Microscopical Examination of thin Sections; Chemical Composition, where necessary; Density; Tests of Strength; Permanence of Color; Absorptive Properties for Moisture and Water; Weathering Properties; Resistance to Heat; and General Adaptability to Structural Purposes.

For the purpose of this series of investigations, the following material will be required for each stone examined:

Ten (10) cubes of one and one half inches, roughly dressed.

Two (2) cubes of two inches, roughly chipped.

Two (2) cubes, cut out conformably with the bedding of the rock, of two and one half inches, if rock is soft, and of one and one half inches, if rock is hard.

Ten (10) hand specimens, roughly chipped to the size of four and one half inches by three and one half inches by one and one half inches.

Six (6) hand specimens, polished on one side and roughly dressed otherwise, of the size of four and one half inches by three and one half inches by one and one half inches.

Twenty (20) thin chips or flakes, approximately one and one half inches square.

In the preparation of the cubes, it is important to mark which is the edge and which the bedding side, unless this is sufficiently obvious from the texture or grain of the rock.

All of the foregoing specimens should be carefully selected from a sufficient depth to insure fresh material, and as complete freedom as possible from weathered surfaces. In addition, one or two specimens, particularly illustrating the natural weathered surfaces, should be sent.

Each specimen must be carefully wrapped, and all packed firmly in a wooden box, and addressed, with inclosed label, to the "Mining Bureau, Pioneer Building, San Francisco," *freight or express charges prepaid.*

A letter should likewise be addressed to the State Mineralogist, giving detailed information as to the exact locality and extent of deposit, present means of transportation to nearest market, buildings in which the stone may already have been used, and the name of the owner of the quarry.

WILLIAM IRELAN, JR., *State Mineralogist:*

DEAR SIR: I take pleasure in sending to you the results obtained in the testing of a few California building stones. The work was undertaken so late in the year that comparatively little could be accomplished in time for publication in this year's report, and even this can be presented with but little critical comment. The main interest attaching to this kind of work must lie in the thorough examination of all the available building stones of the State, and their comparison, not only with one another, in order that the strong and weak points of each may be well brought out to the end that the appropriate selection of material may be made for any given work, but also with the most celebrated building stones of the East and of Europe, the good and bad qualities of which have been determined by the actual test of use for decades or centuries. It is the belief of the writer that a very large variety of ornamental and useful stones will be furnished by the mountains of this State. The number already discovered is large, and a proper appreciation of their beauty and value is sure to follow the systematic investigation into and publication of their merits. The difficulty of access to places distant from the railways has been a great obstacle to fruitful returns for the labor of prospecting and opening quarries; but difficulties

of this kind are diminishing each year, and the natural result is already evident in the increasing interest taken by quarrymen, architects, and capitalists in our building stone resources. In no country now inhabited by the more highly cultivated races of mankind are the natural conditions for the durability of constructions in stone more kindly than here. Still it behooves us to move carefully now in the very beginning of the development of our quarry resources, in order to avoid such costly mistakes as have been made both in the East and in Europe in the selection of stone for elaborate private and national structures. The construction of the new Post Office building in San Francisco will soon make it a matter of great practical importance, as well as of general interest, to know what building stones the State can furnish that shall meet all the requirements of durability, strength, and beauty. The following results as a mere beginning in this direction are formulated as a contribution from the Mineralogical Department of the State University towards a better knowledge of our resources in this direction.

Before proceeding to the description of results, a few words concerning the methods of examination may be in place.* For purposes of an exact mineralogical determination, a thin chip of the stone is ground to an even surface with emery and water, on a rotating iron lathe, then ground fine with flour of emery and water. The side thus prepared is then cemented, by means of Canada balsam, to a small square of thick plate glass, which furnishes the means for holding it steadily while the rough side is gradually ground away, first with coarse then with fine emery, until the section of rock is perfectly transparent, not exceeding 0.025 to 0.05 mm. in thickness. The section is then transferred to a microscope slide, covered with a thin glass cover, and is then ready for study and for permanent record. Three sections of each stone are prepared, one parallel to the bedding, and one in each of two directions at right angles to each other and to the bedding.

The determination of the specific gravity was made in the usual way with an analytical balance. Roughly cubical specimens of about 75 grammes weight were dried at 100° C. to a constant weight (six days), weighed in air, and then weighed suspended in water by a horsehair, after prolonged immersion. The weight of the dried cube divided by the loss of weight on suspension in water, was taken as the specific gravity. The weight of one cubic foot was then calculated from the weight of a cubic foot of water equal to sixty-five and one half pounds.

The crushing strength was determined by the Riehl testing machine of the Mechanical Department of the University, through the courtesy of Professor Hesse, and the kindly coöperation of Mr. Sladky. The maximum capacity of the machine is fifty thousand pounds, so that the size of the cubes used was necessarily limited to less than the usual two-inch cube. The tests were made at the last moment before the transmission of this report, on but two specimens of each rock, one on the bed and one on the edge, and consequently must be considered only approximate. During the coming year they will be carefully repeated with a large number of cubes of each rock.

The absorption of moisture was determined by exposing carefully dried, roughly cubical fragments, of about seventy-five grammes weight, in a saturated atmosphere of water-vapor for seven weeks. The specimens were placed on a glass shelf under a bell jar over standing water. The absorption of water was determined by exposing still another set of stones

*See Geol. of Minnesota, vol. I, p. 185.

of about seventy grammes weight, in a vessel of water for — days. They were carefully dried and weighed first, and the increase of weight after immersion represented the amount of water taken up.

The action of carbonic acid was determined by immersing carefully dried and weighed rough cubes of the same size as the preceding, in water kept saturated by carbonic acid. The loss of weight was inconsiderable unless the stone contained an appreciable amount of carbonate of lime.

The exposure of weighed fragments to strong corroding acid and chlorine fumes, was made to determine the weathering and staining effect that could be produced within the short period of exposure (seven weeks), as indicative of what might be expected from the long continued exposure to the natural weathering agencies in buildings. The effect of dry heat was obtained by exposing cubes of stone in a muffle furnace raised to a red heat. The cubes were gradually heated up to a full redness and then changes of color, cracking, or softening noted. The cubes were then removed, and after cooling below red heat, plunged into cold water and further changes noted.

The tests thus noted by no means furnish all the information it is desirable to obtain concerning the rocks examined. It is hoped that the final report may include the results of the examination of the quarries to determine the extent of the supply, appearance, and behavior of the stone on weathered surfaces, and facilities for quarrying and transportation; further, an enumeration and examination of the structures in which the stone has been used, and the cost of delivery in the San Francisco market.

Five sets of stones have been received; two kinds of Santa Susanna sandstone from the Gilbert Stone Company, of Los Angeles; one sandstone from Robert Rangeley, of Henley, Siskiyou County; Colton marble from the Colton Marble and Lime Company, of Colton; and a volcanic tufa from the Campo Seco Stone Agency, San Francisco. I give below the results thus far obtained from an examination of these stones.

SANTA SUSANNA SANDSTONE.

Two varieties of this stone were sent by the Gilbert Stone Company, one very coarse-grained and the other very fine-grained.

I. Coarse-Grained Sandstone.

Macroscopic.—To the unaided eye the rock appears as a very coarse-grained, light grayish-yellow sandstone, consisting of subangular, smoky gray quartz granules, from 5 mm. in diameter downwards, averaging perhaps about 1.5 mm., dull yellowish-white, soft granules, apparently of kaolinized feldspar, numerous small, black, and a few white, mica scales; the whole cemented together by a very slight yellowish argillaceous cement.* An occasional bluish-black slate fragment is observable. The stone can be made to crumble somewhat in the hand on the edges and angles, but in larger fragments it holds well together.

Microscopic.—Thin sections could be prepared only after saturating the fragments to be ground with boiling Canada balsam, and allowing them to cool and harden. Sections were thus obtained thin enough, but they

* The term "cement" is technically used in geology, with reference to the finely divided or fine-grained material which holds together the larger grains of quartz or other mineral entering into the composition of the sandstone. This cementing material, or "cement," is ordinarily clay, carbonate of lime, oxide of iron, or silica, more or less mixed with finely comminuted particles derived by attrition from the larger grains, whence the four chief classes of sandstones: the *argillaceous*, the *calcareous*, the *ferruginous*, and the *silicious*.

went to pieces during the final mounting. The above mentioned constituents are all readily recognizable. The quartz is greatly in excess in sharply angular granules from the largest size (5 mm.) down to minute grains. The quartz substance is quite clear, or with bands or clouds of tiny liquid cavities, with movable bubbles, minute yellowish patches of hydrated ferric oxide, now and then a few colorless cylindrical microlites (perhaps apatite), or thickly interpenetrated in every direction with long, exceedingly delicate hair-like forms (possibly asbestos).

The feldspar is present both as potash and as soda-lime feldspar; its granules rarely exceed 1 mm. or 1.5 mm. in diameter, and diminish from this down to the minute particles which make up the cement. It presents every stage of decomposition, and consequent softening, from comparatively fresh substance, showing the brilliant bands of plagioclas between crossed nicols in polarized light, down to the more or less completely kaolinized mass that has become dull white, soft, and opaque. Roughly estimated the quartz makes up perhaps three quarters of the granular constituents, and the feldspars and mica scales the remainder. The mica scales (the black largely in excess) are abundant and closely wedged in between the quartz and feldspar granules, with their cleavage surfaces mainly in the plane of the rock-bedding. The white scales are still fresh, and from their toughness add to the strength of the stone. The black mica has, however, lost its elasticity and toughness, and by its partial decomposition has furnished much of the yellow oxide of iron, to which the color of the stone is due.

Cement.—The small proportion of cement present is easily seen in the thin sections. The above described granules are either in actual contact or separated by a thin film of yellowish argillaceous material, derived from the decomposition of the feldspars. In an uncovered section one can likewise discern delicate patches and films of snowy white substance, which is evidently the carbonate of lime that effervesces at numerous detached spots when the surface of the stone is moistened with chlorhydric acid. Like the kaolin of the cement, it also was probably derived from the decomposition of the feldspars.

The specific gravity of the stone is 2.62, whence the weight of one cubic foot equals 163.7 pounds. The amount of moisture absorbed in seven weeks equals 1.51 per cent of the weight of the stone, and the amount of water to 5.33 per cent. The effect of strong corroding acid fumes was very marked. The stone became somewhat discolored with yellow iron oxide stains, and crumbled considerably, losing 3.7 per cent of its weight standing untouched on the glass shelf upon which it was exposed, and 3.6 per cent more upon being brushed with a moderately stiff brush. The stone was entirely unaffected by heat, except that it changed color to a beautiful brownish-red, and subsequent exposure to water, while still hot, failed to crack or scale it in the least.

The crushing strength, determined from a single cube for edge and another single cube for bed, amounts to five thousand eight hundred and twelve pounds per square inch for *bed*, six thousand eight hundred and twenty-eight pounds per square inch for *edge*. The dimensions of the bed-cube were 1.395 inch by 1.416 inch by 1.183 inch, and of the edge-cube 1.380 inch by 1.394 inch by 1.350 inch. In each case the last dimension was the height of the cube.

Occurrence.—According to the sender, an official of the Gilbert Stone Company, Los Angeles, the stone occurs in bowlders, of which the company has an inexhaustible supply in the Santa Susanna Mountains, about eight miles southwesterly from San Fernando Station, on the Southern Pacific

Railroad, in Los Angeles County, and about twenty-eight miles from Los Angeles City. Great difficulty is at present experienced in getting the stone hauled from the quarries to the railroad. The cost of hauling is $1 50 per ton, and the cost from San Fernando to Los Angeles is $1 per ton. The sandstone beds cover an area of two and one half miles in length by one mile in width, and the beds of the finer grained stone are said to be one half mile in thickness. Both the Southern Pacific and the Atchison, Topeka, and Santa Fe Railroads are expected to run through the immediate vicinity of these beds, and thus furnish a ready means of transportation to market.

II. Fine-Grained Sandstone.

Macroscopic.—This variety differs in appearance from the former in the size of the grain. It is a beautiful evenly fine-grained stone, of nearly uniform light, grayish-yellow, minutely specked with black and silver-white mica scales. Under the microscope, all of the characteristics of the preceding rock reappear here. While a thin layer of the stone occurs now and then in which granules 1½ mm. diameter occur, in general the average grain does not exceed 0.15 mm. to 0.20 mm. Hardly a trace of effervescence is noticeable when the rock is moistened with chlorhydric acid, nor even when the rock powder is heated with acid.

The specific gravity is 2.52; weight of one cubic foot is 157.5 pounds; absorption of moisture, 1.19 per cent; absorption of water, 6.19 per cent; loss on exposure to carbonic acid gas solution, 0.27 per cent. Exposed to acid fumes, the stone was stained brownish-yellow in spots, became loosely coherent on the surface, lost 7.77 per cent through quiet disintegration, and an additional 9.13 per cent by brushing. In the muffle furnace its color changed to a deep brownish-red, but no crack nor flaw developed in the stone up to full red heat, nor on subsequent immersion, while hot, in water. The crushing strength determined on cubes 1.425 in. × 1.465 in. × 1.359 in. (ht.) for *bed*, and 1.291 in. × 1.258 in. × 1.147 in. (ht.) for *edge*, resulted in 9,752 pounds per square inch for *bed*, and 7,380 pounds per square inch for *edge*. The specimens examined came from six to twelve inches from the face of the sandstone bed.

For occurrence, see above under the coarse-grained sandstone.

Henley Sandstone.

Macroscopic.—The Henley sandstone is a moderately fine-grained, light bluish-gray stone, showing to the unaided eye, dark gray and whitish quartz granules, with numerous black and few white mica scales, held together by a slight argillaceous and calcareous cement. A somewhat free effervescence follows the moistening of the surface with acid. The stone will work easily, and in specimens appears quite free from flaws.

Microscopic.—The quartz granules are most numerous. They are subangular in shape, varying in diameter from 2 mm. downwards, averaging 0.33 mm. The quartz substance is, in the main, quite clear, except for the fluid cavities that are thickly crowded in many of the granules. These cavities vary in size from 0.02 mm. down to the minutest dimensions. While mostly oval, they occur also in the most curiously irregular branching forms, and now and then in the familiar shape of the quartz crystal; the cavity repeating in negative the external dihexahedral form of quartz. Some are completely filled with fluid; others contain liquid with a little bubble in constant motion; others have a stationary bubble; others again are filled with a liquid that does not wet the sides of the cavity, so that it appears in the form of a bubble so large as to fill all except the outer

irregularities of the cavity. Finally, some of the cavities appear to contain *two* bubbles, one within the other. We have in such cases two liquids that will not mix. In one such that was measured, the cavity was .008 mm. in diameter; the outer fluid .007 mm., and the inner one .004 mm.; the latter was in constant motion within the limits of the outer fluid.

Feldspar granules are also present, constituting more than one third the mass of the rock. The feldspar is usually so decomposed that its granules are whitish opaque in thin sections; the fresher granules still show, however, the banded structure of plagioclase in polarized light between crossed nicols.

The numerous black mica scales are much decomposed, the different laminæ often forced asunder by opaque white calcitic decomposition products. The white mica scales are much fewer and, as usual, quite fresh. An occasional magnetic oxide of iron granule, not exceeding 0.1 mm. in diameter, is observable.

Cement.—The cement consists of a mixture of argillaceous and calcareous material mixed with the finest granules of quartz and feldspar, and colored throughout slightly yellowish by the oxide of iron. The specific gravity is 2.63; weight of one cubic foot 164.5 pounds. The absorption of moisture equals 1.78 per cent, the absorption of water 4.07 per cent, and the loss by exposure to carbonic acid equals 0.35 per cent. Exposure to corroding acid fumes changed the color from gray to bright yellow, and rendered the stone crumbly on the surface. The loss by quiet disintegration was 3.27 per cent, and the further loss by brushing was 2.28 per cent, making the total loss 5.55 per cent.

In the muffle this sandstone cracked and scaled somewhat below a red heat, and changed its color, on full red heat, to a brownish-yellow. No further cracking was noticeable upon immersion of the hot cube in water.

The crushing strength was determined on a bed-cube 1.418 in. × 1.354 in. × 1.271 in. (ht.) yielding 12,601 pounds per square inch; and on an edge-cube 1.309 in. × 1.404 in. × 1.476 in. (ht.), yielding 8,722 pounds per square inch.

Occurrence.—The owner of the quarry, Mr. Robert Rangeley, of Henley, Siskiyou County, states that the sandstone beds are behind the town of Henley, and within one mile of Hornbroke Station on the California and Oregon Railroad; that the supply is inexhaustible, and that the stone was used in the construction of the abutments for the railroad bridge over the Klamath River.

Campo Seco Tufa.

Macroscopic.—The Campo Seco tufa is a dull, grayish-white, earthy-looking stone, that to the casual glance seems to be fairly homogeneous in color and compact in texture, except for the occurrence of irregularly-shaped, soft, snowy-white fragments, with delicate, silky luster, immediately suggestive of pumice fragments. They are from 30 mm. in length downwards, and are much softer than the surrounding rock. More closely observed, one sees, in the apparently compact mass, whitish fragments with glassy luster, whose good cleavage betrays their feldspathic character; brownish, angular fragments, otherwise similar to the surrounding stone, and a few minute hexagonal scales of black mica. All of these fragments lie imbedded in a whitish, earthy, but coherent mass, showing in hand specimen an apparently massive texture, no appearance of lamination being visible. On the cubes polished for the crushing tests, and on thin sections cut in the right direction, a very marked, banded texture is developed, due to alternating broader bands (3 mm.) colored delicately brownish-red and

narrower bands of the whitish colored material; the bands are seen but faintly on a ground surface, and distinctly only on a polished surface.

The stone is quite soft, easily admitting sawing into blocks and slabs, and yet is remarkably coherent, as the comparative high crushing strength testifies. Mr. Morton A. Edwards, of San Francisco, the sender of the specimens tested, states that two years' experience has proved that the tufa hardens somewhat on exposure to the weather.

Microscopic.—Under the microscope the stone is seen to consist mainly of clear, colorless, sharply angular, and exceedingly irregularly shaped glass fragments, from 0.75 mm. in diameter to the minutest dimensions, in a cement of excessively finely comminuted isotropic material, which the highest objectives ($\times$ 1,000) resolve into colorless or slightly brownish oblong or rounded transparent granules.

Through this mass are scattered fragments of fibrous and cellular pumice, filled with the characteristic elongated or rounded gas cavities, fragments of fresh samidin feldspar characterized by cleavage and Carlsbad twinning, plagioclase feldspar, recognizable by the bands in polarized light, and fragments of a brownish tufa, identical in general appearance and constitution with the mass of the stone, but with its cement colored brown and rendered opaque by iron oxide. All these fragments are of decidedly secondary importance in the composition of the stone.

The specific gravity is 2.322; the weight of one cubic foot is 145.12 pounds. The amount of moisture absorbed in seven weeks is 2.02 per cent of weight of the stone, and the amount of water absorbed is 10.92 per cent; 9.62 per cent of water is absorbed within four days after immersion, so that the subsequent absorption is not considerable. The effect of exposure to strong acid fumes was inappreciable; the stone was not stained in the least, and was just as firm and coherent as when first exposed. The loss by exposure to carbonic acid solution equals 0.48 per cent. The effect of heat upon the stone is very marked. A comparatively low heat develops a clouded dark color and numerous superficial cracks. A full red heat fused the surface of the cube in contact with the muffle, shrunk the rock perceptibly, and subsequent immersion in water cracked the stone throughout, so that large fragments fell off in handling. The delicately shaded bands before described in the natural rock, became deep brownish-red in color, and very prominent.

The crushing strength determined on a *bed*-cube 1.356 in. $\times$ 1.406 in. $\times$ 1.433 in. (ht.), gave 7,469 pounds per square inch; and on an *edge*-cube 1.325 in. $\times$ 1.402 in. $\times$ 1.461 in. (ht.) gave 7,262 pounds per square inch.

Occurrence.—Mr. Edwards states that there is an inexhaustible supply of the quarries near Campo Seco, in Calaveras County. The stone has not yet been used in San Francisco.

Colton Marble.

From the Colton Marble and Lime Company, of Colton, Los Angeles County, specimens were received illustrating three varieties of marble: a nearly pure white, a white clouded with gray, and a grayish-black finely mottled with white. Most of the specimens were of the clouded white variety, and the examinations made have special reference to this stone.

Microscopic.—The clouded Colton marble is a medium-grained, granular limestone, homogeneous in texture, and so far as can be judged from hand specimens, quite sound and strong. It takes a good polish, but closely observed on a polished surface, unless the polishing has been very carefully done, a thick sprinkling of duller granules in the more perfectly pol-

ished ground can be seen. Two different kinds of granules are evidently present, with different degrees of hardness. Chemical examination showed the presence of about 6 per cent of carbonate of magnesia, and the subsequent microscopic examination proved that the stone was made up of granules, each showing the characteristic polysynthetic structure of calcite, due to repeated twinning parallel to $-\frac{1}{2}$ R., and other granules without this twinning structure. This observation, taken together with the fact that a residue remains from digestion with cold dilute chlorhydric acid which is in part readily soluble in hot dilute chlorhydric, proves that the limestone is dolomitic and consists of a mechanical mixture of calcite granules (carbonate of lime), and dolomite granules (double carbonate of lime and magnesia). The former have the hardness of 3 in the Mohs scale, and the latter of 4. On the imperfectly polished surface, therefore, the polishing process has continued long enough to polish the softer calcite granules, but not long enough for the harder dolomite granules.

The mechanical mixture of the two kinds of granules can easily be shown by etching a polished surface with cold dilute chlorhydric acid. The calcite readily dissolves, and the dolomitic granules are left in relief. A further residue insoluble in hot dilute chlorhydric acid exists. This consists of granules, which in thin sections of the marble may readily be distinguished, singly or in groups, lying between the carbonate granules now and then inclosed in them. They are colorless, about 0.25 mm. in diameter, polarize in brilliant colors, and have cleavage in one direction, with oblique extinction at a high angle. I reserve their determination for further study. The clouding of the marble is due to small scales and patches of graphite. The more numerous and more closely aggregated the scales the darker the clouding. The grayish-black marble contains the scales *very* thickly disseminated, and even the purest white variety is not entirely free from them. They mar the purity of the color by their appearance here and there in isolated scales or groups of scales.

The specific gravity is 2.75; the weight of one cubic foot is 172.06 pounds. The absorption of water amounts to 0.021 per cent of the weight of the stone and of water to 0.13 per cent. The loss in the carbonic acid solution, after seven weeks' exposure, amounted to 0.97 per cent. No change was observed at first when heated in the muffle, except, perhaps, an increased whiteness. At a full red heat it becomes mottled dull-white on a polished surface, loses its strength and coherence on the edges, and develops minute cracks all over the surface that do not penetrate far inward. Its general strength is fairly well preserved. Exposure, while still hot, to water, causes considerable disintegration on the edges.

The crushing strength was determined on a bed-cube, 1.422 in. × 1.414 in. × 1.434 in. (ht.), giving 17,783 pounds per square inch, and on an edge-cube 1.469 in. × 1.429 in. × 1.519 in. (ht.), giving 17,095 pounds per square inch.

Mr. O. T. Dyer, President of the Colton Marble and Lime Company, states that the company owns an inexhaustible supply of the marble in all shades and colors, and that the quarries are located at Colton, Los Angeles County, within one half mile of the junction of the Southern Pacific Railroad and the California Central Railroad. Both roads have built switches and side-tracks to the quarries. The stone can be quarried in large blocks without seams, suitable for large pillars, shafts, etc.

A further study of this stone will be made for next year's report.

A. WENDELL JACKSON,
Professor of Mineralogy, Petrography, and Economic Geology, University of California.

STATISTICS

OF

WELLS, FARGO & CO.

REPORT OF WELLS, FARGO & CO.

PRECIOUS METALS PRODUCT, UNITED STATES OF AMERICA AND MEXICO.

San Francisco, December 31, 1887.

Dear Sir: The following is a copy of our annual statement of precious metals produced in the States and Territories west of the Missouri River (including British Columbia, and receipts by express from the west coast States of Mexico) during 1887, which shows aggregate products as follows: Gold, $33,074,022; silver, $51,578,118; copper, $10,362,746; lead, $9,631,073. Total gross result, $104,645,959.

As stated repeatedly, the facilities afforded for the transportation of bullion, ores, and base metals, by the extension of railroads into mining districts, increase the difficulty of verifying the reports of the products from several important localities; especially is this the case in the reports from Colorado and Montana; and the general tendency is to exaggeration when the actual values are not obtainable from authentic sources; but the aggregate result as shown herein, we think may be relied on with reasonable confidence as approximately correct.

States and Territories.	Gold Dust and Bullion by Express.	Gold Dust and Bullion by other Conveyances.	Silver Bullion by Express.	Ores and Base Bullion by Freight.	Total.
California	$10,760,052	$1,076,905	$972,707	$853,259	$13,662,923
Nevada	2,590,962		5,355,647	2,285,844	10,232,453
Oregon	650,000	300,000			950,000
Washington	130,000	30,000			160,000
Alaska	559,000	50,000			609,000
Idaho	1,940,000	200,000	2,800,000	3,300,000	8,240,000
Montana	4,400,000	200,000	10,783,275	10,100,000	25,483,275
Utah	13,910		2,049,090	5,574,730	7,637,730
Colorado	4,900,000		6,480,000	11,913,000	23,293,000
New Mexico	147,800	50,000	279,434	3,752,000	4,229,234
Arizona	680,545	200,000	1,073,985	3,817,020	5,771,550
Dakota	2,385,320	200,000	473,285		3,058,605
Mexico (West Coast States)	17,801		744,234		762,035
British Columbia	556,154				556,154
Totals	$29,731,544	$2,306,905	$31,011,657	$41,595,853	$104,645,959

The gross yield for 1887, shown above, segregated, is approximately as follows:

Gold	$31\frac{61}{100}$	$33,074,022
Silver	$49\frac{29}{100}$	51,578,118
Copper	$9\frac{90}{100}$	10,362,746
Lead	$9\frac{20}{100}$	9,631,073
Total		$104,645,959

ANNUAL PRODUCTS OF LEAD, COPPER, SILVER, AND GOLD IN THE STATES AND TERRITORIES WEST OF THE MISSOURI RIVER, 1870–1887.

YEAR.	Production, as per W. F. & Co.'s statements, including Amounts from British Columbia and West Coast of Mexico.	Product after deducting Amounts from British Columbia and West Coast of Mexico.	The Net Products of the States and Territories West of the Missouri River, exclusive of British Columbia and West Coast of Mexico, divided, is as follows:			
			Lead.	Copper.	Silver.	Gold.
1870..	$54,000,000	$52,150,000	$1,080,000	....	$17,320,000	$33,750,000
1871..	58,284,000	55,784,000	2,100,000	....	19,286,000	34,398,000
1872..	62,236,959	60,351,824	2,250,000	....	19,924,429	38,177,395
1873..	72,258,693	70,139,860	3,450,000	....	27,483,302	39,206,558
1874..	74,401,045	71,965,610	3,800,000	....	29,699,122	38,466,488
1875..	80,889,057	76,703,433	5,100,000	....	31,635,239	39,968,194
1876..	90,875,173	87,219,859	5,040,000	....	39,292,924	42,886,935
1877..	98,421,754	95,811,582	5,085,250	....	45,846,109	44,880,223
1878..	81,154,622	78,276,167	3,452,000	....	37,248,137	37,576,030
1879..	75,349,501	72,688,888	4,185,769	....	37,032,857	31,470,262
1880..	80,167,936	77,232,512	5,742,390	$898,000	38,033,055	32,559,067
1881..	84,504,417	81,198,474	6,361,902	1,195,000	42,987,613	30,653,959
1882..	92,411,835	89,207,549	8,008,155	4,055,037	48,133,039	29,011,318
1883..	90,313,612	84,639,212	8,163,550	5,683,921	42,975,101	27,816,640
1884..	84,975,954	81,633,835	6,834,091	6,086,252	43,529,925	25,183,567
1885..	90,181,260	87,311,382	8,562,991	7,838,036	44,516,599	26,393,756
1886..	103,011,761	100,160,222	9,185,192	9,276,755	52,136,851	29,561,424
1887..	104,645,959	103,327,770	9,631,073	10,362,746	50,833,884	32,500,067

The exports of silver during the past year to Japan, China, the Straits, etc., have been as follows: From London, $23,861,805; from Marseilles, $4,699,906; from Venice, $———; from San Francisco, $14,444,907. Total, $43,006,618, as against $44,034,590 last year. (Pounds sterling estimated at $4 84.)

UNITED STATES OF MEXICO.

STATEMENT OF THE PRODUCT OF GOLD AND SILVER IN THE REPUBLIC OF MEXICO, REVISED AND CORRECTED, FROM 1877 TO 1887.

YEARS.	Gold.	Silver.	Total.
1877–1878	$747,000	$24,837,000	$25,584,000
1878–1879	881,000	25,125,000	26,006,000
1879–1880	942,000	26,800,000	27,742,000
1880–1881	1,013,000	29,234,000	30,247,000
1881–1882	937,000	29,329,000	30,266,000
1882–1883	956,000	29,569,000	30,525,000
1883–1884	1,055,000	31,695,000	32,750,000
1884–1885	914,000	33,226,000	34,140,000
1885–1886	1,026,000	34,112,000	35,138,000
1886–1887	1,047,000	34,600,000	35,647,000
Totals	$9,518,000	$298,527,000	$308,045,000

EXHIBIT OF COINAGE OF GOLD, SILVER, AND COPPER, IN THE REPUBLIC OF MEXICO, FROM THE FIRST OF JULY, 1873, TO THE THIRTIETH OF JUNE, 1887.

YEARS.	Gold.	Silver.	Copper.
1873-1874	$866,743	$18,846,067	$15,966
1874-1875	862,619	19,386,958	21,712
1875-1876	809,401	19,454,054	30,654
1876-1877	695,750	21,415,128	9,035
1877-1878	691,998	22,084,203	41,364
1878-1879	658,206	22,162,987	16,300
1879-1880	521,826	24,018,528	14,035
1880-1881	492,068	24,617,395	42,258
1881-1882	452,590	25,146,260	11,972
1882-1883	407,600	24,083,921	....
1883-1884	328,698	25,377,379	....
1884-1885	423,250	25,840,728	....
1885-1886	425,000	25,850,000	....
1886-1887	410,000	25,600,000	....
Totals	$8,045,749	$323,883,608	$203,296

SUMMARY—TOTALS.

Gold	$8,045,749
Silver	323,883,608
Copper	203,296
Grand total	$332,132,653

EXHIBIT OF THE COINAGE OF MEXICO FROM THE ESTABLISHMENT OF THE MINTS IN 1537 TO THE END OF THE FISCAL YEAR OF 1887.

DATES OF COINAGE.	Gold.	Silver.	Copper.	Total.
Colonial Epoch.				
Unmilled coin from 1537 to 1731	$8,497,950	$752,067,456	$200,000	$760,765,406
Pillar coin, 1732 to 1771	19,889,014	441,629,211	....	461,518,225
Bust coin, 1772 to 1821	40,391,447	888,563,989	342,893	929,298 329
Totals	$68,778,411	$2.082,260,656	$542.893	$2,151,581,960
Independence.				
Iturbide's imp'l bust, 1822 to 1823	$557,392	$18,575,569	....	$19,132,961
Republic eagle, 1824 to June 30, 1873	45,040,628	740,246,485	$5,235,177	790,522,290
Totals	$45,598,020	$758,822,054	$5,235,177	$809,655,251
Republic.				
Eagle coin, from July 1, 1873, to June 30, 1887	$8,045,749	$323,883,608	$203,296	$332,132,653

SUMMARY.

Colonial Epoch, from 1537 to 1821	$2,151,581,960
Independence, from 1822 to 1873	809,655,251
Republic, from 1873 to 1887	332,132,653
Total	$3,293,369,864

The exhibits of production and mintage indicate a steady development of the mining interests of the United States of America, and also of Mexico, and with the increasing facilities of railway communication fostering every department of industry, the outlook for a continued growth in the product of precious metals is flattering.

JOHN J. VALENTINE,
Vice-President and General Manager Wells, Fargo & Co.

CATALOGUE

OF

CALIFORNIAN FOSSILS.

CATALOGUE OF CALIFORNIAN FOSSILS.

Compiled by J. G. Cooper, M.D.

The latest published catalogue of fossils (including many from other portions of the Pacific Slope between Alaska and Mexico), was that given in Vol. II Palæontology of California, issued in 1869. Between that time and the final suspension of the State Geological Survey under Professor J. D. Whitney, in 1874, considerable additions to the collections were made by members of the survey, and important contributions presented by assistants in the United States Coast Survey under Professor Davidson, Dr. L. G. Yates, of Santa Barbara, and others, mentioned in Professor Whitney's works on the "Auriferous Gravels of the Sierra Nevada," the "Climatic Changes of Recent Geological Times," and Professor Lesquereux's descriptions of "Fossil Plants of California, Oregon," etc. We are also indebted to Rev. S. Bowers, of San Buenaventura, for additions to the known fossils of the Quaternary beds near Santa Barbara, and to Dr. L. G. Yates for later additions to the list of localities of Mesozoic and Tertiary fossils. The United States Geological Surveys have also added very much to our previous knowledge of their distribution, especially in relation to the fresh-water quaternary deposits of the Great Basin east of the Sierra Nevada, which extend over much of the northeastern and southeastern counties of California, with a few additions to the marine fossils from more western counties, described by Dr. C. A. White. The publications relating to the geology of the other western States and Territories, as well as those of the Canadian surveys, have extended our knowledge of the distribution of Californian fossils, showing more clearly their relations to geological changes in the earth's surface, together with those in climate and productions. The connection between fossils and mineral products is another important reason for recording the localities in which similar deposits are proved by their fossils to exist, and therefore great care has been taken to include all such facts.

Much assistance has been rendered in preparing and revising this catalogue by Professor Whitney, now of Harvard University, Professor Leidy and Professor Cope, of Philadelphia, Professor St. John, of Kansas, Professor Dall, of Washington, D. C., and other specialists.

A number of species have also been added to the lists of the latter formations about San Diego, from the collections of Mr. H. Hemphill, as determined by Professor W. H. Dall, of the United States National Museum. The following table shows the advance made in our knowledge of the fossils since 1869.

Localities along the coast are usually in counties of the same names, and well known. Those inland, and all little known, have the county name added. Numerous new localities and many additional species have been added to those given in the reports of the Geological Survey of California, 1860 to 1874. Much is also added from the Canadian and United States Geological Surveys up to the present date. It must be remarked that the exact geological position of many fossils in the Tertiary and Cretaceous strata is still unsettled, there not being such distinct divisions between them in California as in some countries. The mollusca, etc., found in the

strata called Upper Cretaceous (Div. B) by the former survey, are now generally admitted to represent the Eocene Tertiary, but its exact limits have not been determined.

A few changes have been made in names before published, to correspond with recent advances in science.

The divisions of the fresh water deposits of the auriferous gravels and coast ranges are also unsettled.

L.—Living, the present geographical range being given.
T.—Terrestrial (land shells).
F.—Fresh-water shells (all others marine).
Eoc.—Eocene.
Mioc.—Miocene tertiary.
Pl.—Pliocene.
Quat.—Quaternary (post-pliocene).
(*Not ident.*)—Not identified among the fossils found by the State Geological Survey under Whitney, but where much resembling a described species its name is given.

TERTIARY AND QUATERNARY MAMMALIA.

The human remains found in the Sierra Nevada are apparently as old as those of some of the extinct animals here mentioned, with which they are imbedded, thus carrying back their age to the beginning of the Quaternary Epoch. Professor Whitney thinks they even belong to the Pliocene, and as that is a still unsettled question, the reader is referred to his "Auriferous Gravels," and other works, for information.

It is suggested that these fossils, being only fragments, have been washed down during the Quaternary Epoch, from older tertiary strata into the more recent, and thus represent only that and later deposits. (See list of fossil plants.)

Aphelops hesperius Leidy.

(*Related to the Rhinoceros.*)

Mioc.—Douglas Flat and Chili Gulch, Calaveras County. Bones found beneath the lava only. Also believed to be found in Eastern Oregon, together with remains of two other species of rhinoceros, distinct from any now living.

Arctotherium simum Cope.

Extinct Bear.

Quat.—Found in a cave in limestone of Shasta County by describer. Teeth differ from those of living bears, but other similar species have been found in South America fossil; size of the grizzly bear.

Bison latifrons Harlan.

The extinct American Buffalo.

Pl.?—Kincaid Flat, Tuolumne County, above the lava.
Quat.—Near Millerton, Fresno County; Pilarcitos Valley, San Mateo County; near Centerville, Alameda County; Texas, and Mississippi Valley.

Canis indianensis Leidy.

An extinct Wolf.

Pl.—Livermore Valley, Alameda County. (Living? C. occidentalis var.?) Larger than the living form.

Canis latrans Say.

The Coyote or Prairie Wolf.

Living.—Western United States and Mexico.
Pl.—Auriferous gravels, Sierra Nevada (Murphy's? Calaveras County).

Delphinus occiduus Leidy.

Like a living kind of Porpoise.

Mioc.—Half-moon Bay, San Mateo County.

Desmostylus hesperus Marsh.

Related to the Dugong and Manatee.

Pl.—South of Livermore, Alameda County; Salinas Valley, Monterey County, near lat. 36°.

Elephas americanus DeKay.

(*American Elephant*) *E. Columbi* Falconer.

Pl.?—Auriferous gravels, Sierra Nevada, above the lava.
Quat.—Later strata, Sierra Nevada; whole skeleton twenty miles northwest of Millerton, Fresno County; bones, Coast Range, in later strata; Santa Rosa Island, Santa Barbara County; remains also found in most parts of North America, south of lat. 50°.
E. primigenius in Alaska and on eastern continent.

Elotherium imperator Leidy.

(*Related to the Hog.*)

Mioc.?—Douglas Flat, Calaveras County, under the lava.

Equus excelsus Leidy.

Quat.?—Near Buena Vista Lake, Kern County; Columbia, Tuolumne County; Nebraska. Size of the living horse, but enamel of teeth simpler in upper jaw, like those of the ass.

Equus occidentalis Leidy.

Pl.—Murphy's, Calaveras County, above the lava; Martinez, Contra Costa County; Solano County, foothills; near Centerville, Alameda County; Texas. Larger than any living horses.

Eschrichtius davidsoni Cope.

Fossil Finback Whale.

Pl.?—Same size as the "California Gray Whale." Bones sent from near Santa Barbara by Professor G. Davidson, United States Coast Survey.

Felis imperialis Leidy.

A large species of Lion.

Pl.?—Livermore Valley, Alameda County.

Holomeniscus californicus Leidy.

A Llama, a third larger than the living Camels.

Pl.—Foothills, Merced County.

Holomeniscus hesternus Leidy.

A Llama, smaller than H. californicus.

Pl.—Foothills, Alameda County.

Mastodon americanus Cuvier.

American Mastodon.

Mioc.?—Auriferous gravels, lower beds; some under the lava. From three thousand feet elevation downward, Sierra Nevada. Especially Gold Spring, Tuolumne County, and Horseshoe Bend, Merced County.

Pl.—Above the lava beds, Coast Ranges.

Quat.—Bottle Hill, Mare Island, Solano County. Also, eastward throughout the United States, from near surface to over one hundred feet depth.

Mastodon shephardi Leidy.

Western Mastodon.

Pl.?—Dry Creek, Stanislaus County; Kincaid Flat, Tuolumne County; Oak Spring, Contra Costa County; New Mexico (and southeast coast from Maryland to Georgia? perhaps *M. obscurus* only).

Megalomeryx niobrarensis Leidy.

Pl.?—A large animal of the camel family, first found in Nebraska, but only teeth are yet known. Found beneath the lava, Tuolumne County. Also, in the pliocene of Nebraska.

Protohippus insignis Leidy.

Pl.?—Soulsbyville and Table Mountain, Tuolumne County, beneath the lava, two hundred and ten feet deep. Size of the ass, with grinders like those of the ox, etc.

Found in the pliocene of Texas and Nebraska. Southern California, sixty feet deep (may be another species).

Mylodon? sodalis Cope.

An extinct Sloth.

Quat.—From auriferous gravel of the Klamath River at Yreka, California.

Tapirus americanus? Linnæus.

South American Tapir.

Quat.—Auriferous gravels, Sierra Nevada, above the lava, near Sonora, Tuolumne County; Eastern States. Like a living species found in tropical America, but may be distinct.

TERTIARY FISHES.

Carcharodon rectus Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Echinorhinus blakei Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Galeocerdo productus Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Hemipristis heteropleurus Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Lamna elevata Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Lamna ornata Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Oxyrhina plana Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Oxyrhina tumula Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Prionodon antiquus Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

Scymnus occidentalis Agassiz.

Pl.—Ocoya, or Posa Creek, Kern County.

The above all represent species of sharks, described from the teeth (the only parts preserved as fossils), and similar remains are found in many other localities, especially near the coast.

TERTIARY CRUSTACEA.

Cancer brewerii Gabb.

Pl. or *Mioc.*—Calleguas Ranch, Ventura County.

TERTIARY AND QUATERNARY MOLLUSCA.

Acila castrensis Hinds.

(*A. lyalli* Baird.)

L.—Sitka to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—San Fernando, Los Angeles County; San Diego well.
Mioc.—Oregon; Martinez, Contra Costa County; Griswold's, San Benito County.

Acmæa insessa Hinds.

L.—Baulines Bay to San Diego.
Quat.—San Diego.

Acmæa mitra Escholtz.

L.—Sitka to San Diego.
Quat.—Santa Barbara to San Diego.

Acmæa pelta Escholtz.

L.—Sitka to San Diego.
Quat.—Santa Barbara.

Acmæa persona Escholtz.

L.—Sitka to San Diego; Mazatlan.
Quat.—Santa Barbara to San Nicolas Island.

Acmæa rudis Gabb.

Pl.—San Fernando, Los Angeles County.

Acmæa scabra Nuttall.

L.—Baulines Bay to San Diego; Mazatlan.
Quat.—Santa Barbara.

Acmæa spectrum Nuttall.

L.—Cape Mendocino to San Diego.
Quat.—Santa Barbara; San Pedro.

Acmæa testudinalis Müller.

(*A. patina* Esch.)

L.—Circumpolar to San Diego.
Quat.—Santa Barbara.

Agasoma gravida Gabb.

Mioc.—Martinez, Contra Costa County; Ocoya (Posa) Creek, Kern County.

Agasoma sinuata Gabb.

Mioc.—Walnut Creek, Contra Costa County.

Amphissa corrugata Reeve.

(*A. versicolor* Dall.)

L.—Alaska to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Amnicola longinqua Gould.

L., *F.*—Lake Point, Utah.
Quat.—Lahontan basin (Lassen County), and Nevada; Colorado Desert, San Diego County.

Amusium caurinum Gould.

L.—Straits of Fuca to Santa Barbara; Japan.
Quat.—Santa Barbara; San Pedro.
Pl.—Eagle Prairie, Humboldt County; San Fernando, Los Angeles County.
(*Mioc.*—See *Pecten propatulus.*)

Amycla gausapata Gould.

L.—Alaska to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Kirker's Pass, Contra Costa County.

Amycla tuberosa Carpenter.

L.—Neah Bay to San Diego.
Quat.—Santa Barbara to San Pedro.
Pl.—San Diego well.

Amycla undata Cpr.

L.—Catalina Island.
Quat.—Santa Barbara.

Ancillaria fishii Gabb.

Mioc.—Martinez; Griswold's; San Benito County.

Ancylus newberryi Lea.

L., *F.*—Klamath Lake, Oregon, and northern rivers of California.
Quat.—Lahontan Basin, Lassen County, and Nevada.

Anodonta nuttalliana Lea.

L., *F.*—British Columbia to Arizona.
Quat.—Lake basins east of Sierra Nevada; Colorado Desert, San Diego County. (Includes varieties *californiensis* Lea, *oregonensis* Lea, and *wahlamatensis* Lea.)

Anomia lampe Gray.

L.—"Monterey 60 fms." San Pedro to Mexico.
Quat.—San Pedro.

Anomia limatula Dall.

Quat.—San Pedro.

Anomia subcostata Conrad.

Pl.—West of Colorado Desert, San Diego County.

Arca congesta Conrad. (Not ident.)

"*Mioc.*—Santa Barbara." (Probably variety of *A. microdonta.*)

Arca microdonta Conrad.

Pl.—Santa Rosa, Sonoma County; San Francisco, seven miles beach; Twelve-Mile House, San Mateo County; Half-moon Bay, San Mateo County; Sargents, Santa Clara County; San Diego well.
Mioc.—Martinez, Contra Costa County; Griswold's, San Benito County; Soquel, Santa Cruz County; El Toro Ranch, Monterey County; Foxins, Santa Barbara County; Santa Barbara.

Arca obispoana Conrad. (Not ident.)

"*Mioc.*—San Luis Obispo County." (Probably var. of *A. microdonta.*)

Arca sulcicosta Gabb.

Pl.—Mark West Creek, Sonoma County.

Arcopagia unda Conrad. (Not ident.)

Mioc.—Estrella, San Luis Obispo County; Santa Barbara.
Pl.—San Benito County. (Like *Lutricola alta* Conrad. Living.)

Axinæa intermedia Broderip.

L.—Monterey to San Diego; South America.
Quat.—San Pedro.

Axinæa patula Conrad.

Mioc.—Oregon; Martinez; San Pablo; Walnut Creek, Contra Costa County.
Pl.—Santa Rosa, Sonoma County.

Axinæa profunda Dall.

Quat.—San Diego.

Bittium armillatum Carpenter.

L.—Farallone Islands to San Diego.
Quat.—Santa Barbara.
Pl.—San Diego well.

Bittium asperum Gabb.

L.—Santa Barbara to Catalina Island.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Bittium filosum Gould.

L.—Sitka to Monterey.
Quat.—Santa Barbara.

Bittium quadrifilatum Carpenter.

L.—Monterey to San Diego.
Quat.—Santa Barbara.

Bulla adamsii Menke.

L.—San Pedro to Panama.
Quat.—San Pedro.
Pl.—San Fernando, Los Angeles County.

Bulla jugularis Conrad. (Not ident.)

"*Mioc.*—Ocoya Creek (Posa Creek), Kern County."

Bulla nebulosa Gould.

L.—Santa Barbara to Lower California; Gulf of California.
Quat.—San Diego.
Pl.—San Fernando, Los Angeles County; San Diego well.

Bythinella binneyi Tryon.

L., F.—Marin County to San Diego County, east to Alameda County.
Quat.—Walnut Creek, Contra Costa County. Nevada?

Cadulus fusiformis Phillippi.

L.—West coast of Mexico.
Pl.—San Diego well.

Calliostoma annulatum Martyn.

L.—Straits of Fuca to San Diego.
Quat.—San Pedro to San Diego.
Pl.—San Diego well.

Calliostoma canaliculatum Martyn.

L.—Straits of Fuca to San Diego.
Quat.—San Pedro to San Diego.

Calliostoma costatum Martyn.

L.—Sitka to San Diego.
Quat.—San Pedro to San Diego.
Pl.—San Fernando, Los Angeles County.

Calliostoma gemmulatum Carpenter.

L.—San Pedro to San Diego.
Quat.—San Pedro to San Diego.

Calliostoma tricolor Gabb.

L.—New Year Point to San Diego.
Quat.—San Pedro to San Diego.

Callista voyi Gabb.

Pl.—Eagle Prairie, Humboldt County; Kirker's Pass, Contra Costa County; Lobitos, San Mateo County; Sargents, Santa Clara County; Soquel, Santa Cruz County. (Probably same as *Venus pajaroensis* Conrad, a prior species.)

Callista newcombiana Gabb.

L.—Monterey to Catalina Island.
Quat.—San Diego.
Pl.—San Diego well.

Cancellaria altispira Gabb.

Pl.—San Fernando, Los Angeles County.

Cancellaria gracilior Carpenter.

Quat.—Santa Barbara.

Cancellaria tritonidea Gabb.

Quat.—Coyote Creek, Ventura County; San Pedro.

Cancellaria vetusta Gabb.

Mioc.—Martinez, Contra Costa County; Coyote Creek, Ventura County.

Capulus tumens Carpenter.

L.—Monterey to San Diego and Islands.
Quat.—San Pedro.

Cardium blandum Gould.

L.—Sitka to Monterey. Asia?
Quat.—San Pedro.
Pl.—Eagle Prairie, Humboldt County.
Mioc.—Walnut creek, Contra Costa County; El Toro Ranch, Monterey County.

Cardium centifilosum Carpenter.

L.—Monterey to Catalina Island.
Quat.—San Pedro.
Pl.—San Diego well.
Mioc.—Sunol, Alameda County.

Cardium corbis Martyn.

L.—Kodiak to Santa Barbara; Kamtschatka.
Quat.—San Francisco; Monterey; San Pedro.

Cardium graniferum Sowerby.

L.—West coast of Mexico to South America.
Quat.—Santa Barbara (also *Pl.?*).

Cardium meekianum Gabb.

Pl.—Eagle Prairie, Humboldt County; Santa Rosa, Sonoma County; Green Valley, Contra Costa County; Santa Cruz.

Cardium modestum Conrad. (Not ident.)

"*Mioc.*—San Diego Mission."
(Like *Hemicardium biangulatum*, Sowerby.
L.—Catalina Island; Mexico; Panama.)

Cardium panamense Sowerby.

L.—West tropical America.
Quat.—San Pedro; San Diego.

Cardium procerum Sowerby.

L.—West tropical America.
Pl.—San Diego well.

Cardium quadragenarium Conrad.

L.—Monterey to San Diego.
Quat.—San Diego.
Pl.—Calleguas Ranch, Ventura County.

Carinifex newberryi Lea.

L., *F.*—Klamath Lake, Oregon, to Clear Lake, Lake County, and Owens Lake, Inyo County; Utah.
Quat.—Lahontan Basin, Lassen County, and Nevada.
Pl.—Mission San José, Santa Clara County; Gelcichs coal mine, Santa Cruz County.

Caryatis barbarensis Gabb.

Pl.—Santa Barbara.

Cellepora californiensis Gabb & Horn.

L.? and Quat.—Santa Barbara.

Cemoria crucibuliformis Conrad. (Not ident.)

"*Quat.*—Santa Barbara." (Like *Puncturella cooperi* Carpenter.)

Cerithidea californica Haldemann.

L.—Baulines Bay to San Diego; Mazatlan.
Quat.—San Pedro to San Diego.
Pl.—San Fernando, Los Angeles County.
Mioc.—Santa Monica.

Cerithiopsis assimilata C. B. Adams.

L.—Monterey to Panama.
Quat.—San Diego.

Cerostoma nuttalli Conrad.

L.—Baulines Bay to San Diego.
Quat.—San Diego.

Chama exogyra Conrad.

L.—Bodega Bay to San Diego; Mexico.
Quat.—Santa Barbara to San Pedro.

Chemnitzia chocolata Carpenter.

L.—Monterey to San Diego.
Quat.—San Diego.

Chemnitzia papillosa Trask. (Not ident.)

"*Quat.*—Santa Barbara." (Like *Bittium asperum* Gabb.)

Chemnitzia stylina Carpenter.

L.—Monterey to Santa Barbara.
Quat.—San Diego.
Pl.—San Diego well.

Chemnitzia tenuicula Gould.

Quat.—Santa Barbara.

Chemnitzia torquata Gould.

L.—Straits of Fuca to San Diego.
Pl.—Wheeler's Cañon, Ventura County; San Diego well.

Chione fluctifraga Sowerby.

L.—San Pedro to San Diego; Gulf of California.
Quat.—Santa Barbara; San Diego.
(Is *Amiantis callosa* of Gabb's list, not of Conrad.)

Chione mathewsonii Gabb.

Mioc.—Martinez, Contra Costa County.

Chione pertenuis Gabb.

Mioc.—Martinez, Contra Costa County; Griswold's, San Benito County; Santa Inez, Santa Monica, Santa Barbara County.

Chione simillima Sowerby.

L.—Monterey to San Diego.
Quat.—Santa Barbara to San Diego.

Chione succincta Valenciennes.

L.—Santa Barbara to San Diego; Mexico; South America.
Quat.—Santa Barbara to San Diego.
Pl.—Seven-Mile Beach, San Mateo County; San Fernando, Los Angeles County.
Mioc.—Oregon; Martinez; San Pablo, Contra Costa County; Griswold's, San Benito County; Foxins, Santa Barbara County; Santa Monica, Los Angeles County.

Chione whitneyi Gabb.

Mioc.—Martinez, Contra Costa County; El Toro Ranch, Monterey County.

Chlorostoma aureotinctum Forbes.

L.—Monterey? Santa Barbara to Lower California.
Quat.—Santa Barbara.

Chlorostoma brunneum Philippi.

L.—Cape Mendocino to San Diego.
Quat.—Santa Barbara Island.

Chlorostoma funebrale A. Adams.

L.—Sitka to San Diego.
Quat.—Santa Barbara to San Diego.

Chlorostoma pfeifferi Philippi.

L.—Baulines Bay to San Diego.
Quat.—Santa Barbara to San Diego.

Chorus belcheri Hinds.

L.—Catalina Island to San Diego; Lower California.
Quat.—San Pedro.
Pl.—San Diego well.

Chrysodomus carinatus Dunker.

L.—Sitka, Alaska; Asia.
Pl.—Santa Barbara.

Chrysodomus diegoensis Dall.

Pl.—San Diego well.

Chrysodomus dirus Reeve.

L.—Sitka to Monterey.
Quat.—Santa Barbara.

Chrysodomus liratus Martyn.

L.—Kodiak to Straits of Fuca.
Quat.—Santa Barbara.

Chrysodomus tabulatus Baird.

L.—Straits of Fuca to Catalina Island.
Pl.—Eagle Prairie, Humboldt County; Twelve-Mile House, San Mateo County; San Fernando, Los Angeles County; Santa Barbara; San Pedro.

Clathurella conradiana Gabb.

Pl.—San Diego well.
Quat.—Santa Barbara.

Clementia subdiaphana Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—San Pedro to San Diego.
Pl.—San Diego well.

Clidiophora punctata Conrad.

L.—Straits of Fuca to San Diego.
Pl.—San Benito County.
Mioc.—Ventura County.

Clypidella bimaculata Dall.

L.—Farallone Islands to Santa Barbara Island.
Quat.—Santa Barbara; San Pedro.

Clypidella callomarginata Carpenter.

L.—Lobitos to San Diego.
Quat.—San Pedro to San Diego.

Cochliopa rowellii Tryon.

L., *F.*—Panama?
Quat.—Walnut Creek, Contra Costa County.

Cæcum californicum Dall.

(*Cæcum cooperi* Carpenter, not of Smith.)

L.—San Diego Bay and Islands.
Quat.—San Diego.

Columbella richthofeni Gabb.

Pl.—Russian River, Sonoma County; Seven-Mile Beach, San Mateo County; San Fernando, Los Angeles County.

Colus dupetithouarsi Kiener.

L.—West Mexican Coast.
Quat.—Santa Barbara.
Pl.—Santa Barbara; San Diego well.

Conchocele disjuncta Gabb.

Quat.—Dead Man's Island, San Pedro Bay.

Conus californicus Hinds.

L.—Farallone Islands to San Diego; Lower California.
Quat.—Santa Barbara to San Diego.
Pl.—San Fernando, Los Angeles County.

Corbula diegoana Conrad. (Not ident.)

"*Quat.*—San Diego."

Corbula luteola Carpenter.

L.—San Pedro to San Diego.
Quat.—San Diego.

Crassatella collina Conrad.

Pl.?—Sargents?, Santa Clara County.
Mioc.—Santa Inez, Santa Barbara County; Ojai Valley, Ventura County.

Crepidula aculeata Gmelin.

L.—Monterey south; Asia; Atlantic Ocean.
Quat.—San Pedro to San Diego.
Pl.—San Fernando, Los Angeles County.

Crepidula adunca Sowerby.

L.—Straits of Fuca to Santa Barbara; Mexico.
Quat.—Santa Barbara; San Diego.

Crepidula dorsata Broderip.

(*C.—var. lingulata* Gould.)

L.—Straits of Fuca to Mazatlan; Peru, South America.
Quat.—Santa Barbara.
Pl.—San Fernando, Los Angeles County.

Crepidula excavata Broderip.

L.—Sitka to Santa Barbara; Mexico to Peru.
Quat.—Santa Barbara to San Pedro.

Crepidula grandis Middendorf.

Quat.—Santa Barbara; San Pedro.
Pl.—Russian River and Santa Rosa, Sonoma County; Seven-Mile Beach, San Mateo County; Kirker's Pass, Contra Costa County; Santa Cruz; Santa Barbara; San Fernando, Los Angeles County; San Diego well.
Mioc.—Oregon; Tomales, Marin County; Walnut Creek, Contra Costa County; Foxins and Santa Rosa Island, Santa Barbara County.

Crepidula navicelloides Nuttall.

L.—Alaska to San Diego.
Quat.—Santa Barbara.
Pl.—San Diego well.

Crepidula rugosa Nuttall.

L.—Santa Barbara to San Diego; Mexico to Peru?
Quat.—San Pedro to San Diego.

Crucibulum spinosum Sowerby.

L.—San Pedro, south, to Peru, South America.
Quat.—Santa Barbara.
Pl.—San Diego well.

Cryptochiton stelleri Middendorf.

L.—Straits of Fuca to Monterey; Kamtschatka.
Quat.—San Diego.

Cryptodon flexuosus Montagu.

L.—Catalina Island, seven hundred and twenty feet depth; England; Asia?
Quat.—Santa Barbara.
Pl.—Santa Barbara; San Diego well.

Cryptomya californica Conrad.

L.—Straits of Fuca to San Diego.
Quat.—San Diego well.
Pl.—Santa Rosa, Sonoma County; Twelve-Mile House, San Mateo County; Soquel, Santa Cruz County; San Fernando, Los Angeles County; San Diego well.
Mioc.—Siebeck's, Santa Clara County; Griswold's, San Benito County; Foxins, Santa Barbara County.

Cuma biplicata Gabb.

Mioc.—Martinez, Contra Costa County.

Cumingia californica Conrad.

L.—Monterey to San Diego; Mazatlan.
Quat.—Santa Barbara; San Diego.

Cylichna cylindracea Linnæus.

(*C. alba?* Brown.)

L.—Monterey to San Diego; Europe.
Quat.—Santa Barbara; San Diego.
Pl.—San Diego well.

Cyrena californica Gabb.

Pl.—Kirker's Pass, and Green Valley, Contra Costa County; Soquel, Santa Cruz County. (Prime's living species of same name (prior) from Gulf of California seems distinct.)

Daphnella clathrata Gabb.

L.—Catalina Island, three hundred and sixty feet depth.
Pl.—San Diego well.

Dentalium hexagonum Sowerby.

L.—Santa Barbara to Mexico; East Indies; China.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Dentalium indianorum Carpenter.

L.—Straits of Fuca to Santa Barbara.
Quat.—Santa Barbara.

Dentalium semipolitum Broderip and Sowerby.

L.—San Diego to Gulf of California.
Pl.—San Diego well.

Diala acuta Carpenter.

L.—Monterey to Catalina Island.
Quat.—Santa Barbara.

Diplodonta orbella Gould.

L.—Straits of Fuca to San Diego.
Quat.—San Pedro to San Diego.
Pl.—San Diego well.

Donax californicus Conrad.

L.—Monterey?; San Luis Obispo to San Diego.
Quat.—San Pedro to San Diego.

Donax flexuosus Gould.

L.—Santa Barbara to San Pedro.
Pl.—San Diego well.

Dosinia conradi Gabb.

Mioc.—Monterey; San Emidio Cañon, Kern County.

Dosinia longula Conrad. (Not ident.)

"*Mioc.*—Salinas Valley, Monterey County."

Dosinia mathewsonii Gabb.

Mioc.—Martinez, Contra Costa County; Suñol, Alameda County; Griswold's, San Benito County; El Toro Ranch, Monterey County.

Dosinia montana Conrad. (Not ident.)

"*Mioc.*—Salinas Valley, Monterey County."

Dosinia ponderosa Gray.

L.—West Mexico to Panama.
Quat.—Santa Barbara to San Diego.
Pl.—Kirker's Pass, Contra Costa County; San Fernando, Los Angeles County.

Dosinia subobliqua Conrad. (Not ident.)

"*Mioc.*—Salinas Valley, Monterey County."

Drillia hemphilli Stearns.

L.—Lower California.
Quat.—San Diego.

Drillia incisa Carpenter.

L.—Straits of Fuca, Washington Territory, to Santa Cruz, California.
Quat.—Santa Barbara to San Pedro.

Drillia inermis Hinds.

L.—Santa Barbara to San Diego, Lower California.
Quat.—Santa Barbara.

Drillia mœsta Carpenter.

L.—Santa Barbara to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Drillia penicillata Carpenter.

L.—San Pedro, south; Cerros Island, Lower California.
Quat.—Santa Barbara to San Diego.

Drillia torosa Carpenter.

L.—Santa Cruz to Santa Barbara.
Quat.—Santa Barbara.

Drillia voyi Gabb.

Pl.—Eagle Prairie, Bear River, Humboldt County.

Entalophora punctulata Gabb & Horn.

L.? and Quat.—Santa Barbara.

Erato columbella Menke.

L.—Monterey to San Diego; Mazatlan.
Quat.—Santa Barbara.

Eulima micans Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara to San Diego.

Eulima rutila Carpenter.

L.—Monterey to San Diego.
Quat.—San Diego.
Pl.—San Diego well.

Ficula nodifera Gabb.

Mioc.—Griswold's, San Benito County.

Ficula ocoyana Conrad. (Not ident.)

"*Mioc.*—Ocoya Creek (Posa Creek), Kern County."

Ficula pyriformis Gabb.

Mioc.—Martinez, Contra Costa County.

Fissurella volcano Reeve.

L.—Santa Cruz to San Diego.
Quat.—Santa Barbara to San Diego.

Fluminicola fusca Haldemann.

L. F.—Oregon to Idaho; Northern California to Utah.
Quat.—Lahontan basin (Lassen County), and Nevada.

Fusus arctatus Conrad. (Not ident.)

Mioc.—Ocoya creek (Posa creek), Kern County.

Fusus barbarensis Trask. (Not ident.)

Quat.—Santa Barbara.

Fusus harfordi Stearns.

L.—Cape Mendocino.
Quat.—San Diego.

Fusus kobelti Dall.

L.—Santa Barbara to San Diego.
Quat.—Santa Barbara to San Pedro.
Pl.—San Diego well.

Fusus robustus Trask.

(*F. kobelti?* Dall.)
Quat.—Santa Barbara.

Fusus rugosus Trask. (Not ident.)

Quat.—Santa Barbara.

Galerus contortus Carpenter.

L.—Santa Barbara to San Diego.
Quat.—Santa Barbara to San Diego.

Galerus costellatus Conrad. (Trochita.)

Mioc.—Santa Inez Mountains, Santa Barbara County; Santa Monica, Los Angeles County.

Galerus diegoanus Conrad. (Trochita.)

Mioc.—San Diego.

Galerus inornatus Gabb.

Mioc.—Halfmoon Bay, San Mateo County.

Galerus fastigiatus Gould.

L.—Puget Sound to Monterey; Vancouver Island.
Pl.—San Diego well.

Galerus filosus Gabb.

Pl.—Twelve-Mile Creek, San Mateo County; Kirker's Pass, Contra Costa County; San Diego well.
Mioc.—Walnut Creek, Contra Costa County; Suñol, Alameda County; Griswold's, San Benito County.

Gari alata Gabb.

Pl.—Kirker's Pass, Contra Costa County.

Glycimeris generosa Gould.

L.—Puget Sound to San Pedro; Kamschatka.
Quat.—Santa Barbara to San Pedro.
Pl.—Santa Barbara; San Fernando, Los Angeles County.
Mioc.—Oregon; Martinez, Walnut Creek, Contra Costa County; Estrella, San Luis Obispo County; Foxin's, Santa Barbara County.

Glyphis aspera Escholtz.

L.—Sitka to San Diego.
Quat.—Santa Barbara to San Pedro.

Glyptostoma-yana Binney.

L., *T.*—Temecula, San Diego County, to Lower California.
Quat.—San Pedro.

Gnathodon mendicus Gould.

L.—Colorado estuary to Mazatlan, Mexico.
Quat.—Colorado desert.

Gonostoma (Ammonitella) yatesii J. G. Cooper.

L., *T.*—Cave City, Calaveras County.
Mioc.—John Day Valley, Oregon.

Gyraulus parvus Say.

L., *F.*—Montana to Nevada; Eastern States.
Quat.—Lahontan Basin (Lassen County), and Nevada.

Gyraulus vermicularis Gould.

L., *F.*—Walla Walla, Washington Territory, to Santa Cruz and Merced County.
Quat.—Walnut Creek, Contra Costa County; Nevada?; Oregon?
Pl.—Gelcich's coal mine, Santa Cruz County.

Haliotis cracherodii Leach.

L.—Farallone Islands to San Diego; Lower California.
Quat.—San Pedro.

Haliotis rufescens Swainson.

L.—Farallone Islands to San Nicolas Island. Galapagos?
Quat.—San Pedro to San Nicolas Island.

Helisoma ammon Gould.

L., *F.*—Klamath Lake, Oregon, to Clear Lake, Lake County, and Colorado River; Honey Lake, Lassen County; Nevada. Semi-fossil in Lahontan Basin.
Quat.—Colorado Desert.

Helisoma trivolvis Say.

L., *F.*—Eastern States; Cuba; across northern United States, north of latitude 40°, only.
Quat.—Lahontan Basin, Lassen County, and east to Bonneville Basin, Utah.

Helix (californiensis) bridgesii Newcomb.

L., *T.*—Contra Costa County to Santa Clara County.
Quat.—Walnut Creek, Contra Costa County.

Helix (californiensis) ramentosa Gould.

L., *T.*—Napa County to Santa Clara County.
Quat.—Sargent's, Santa Clara County; Walnut Creek, Contra Costa County. (Some intermediate.)

Helix exarata Pfeiffer.

L., *T.*—Santa Cruz County to Santa Clara County.
Quat.—Alameda County to Santa Clara County.

Helix (rufocincta?) facta Newcomb.

L., T.—Barbara and Nicolas Islands, California.
Quat.—Barbara Island (larger than living).

Helix fidelis Gray.

L., T.—Vancouver Island to Humboldt Bay, California.
Mioc.—John Day Valley, Oregon.

Helix (rufocincta) gabbi Newcomb.

L., T.—Catalina Island to Clemente Island.
Quat.—Catalina Island (intermediate).

Helix mormonum Pfeiffer.

L., T.—Shasta County to Tulare County.
Quat.—Mariposa and Fresno Counties.
Pl.—Calaveras County.

Helix (mormonum) hillebrandi Newcomb.

L. T.—Tuolumne and Mariposa Counties, California.
Quat.—Near Mariposa (some intermediate).

Helix traskii Newcomb.

(*H. carpenteri*, Newcomb, and *H. remondi*, Tryon.)
L., T.—Mariposa County to Guadalupe Island, Lower California.
Quat.—Santa Paula, Ventura County.

Helix tryoni Newcomb.

L., T.—Barbara and Nicolas Islands, California.
Quat.—Barbara and Nicolas Islands, California (sometimes angled).

Helix tudiculata Binney.

L., T.—Shasta to San Diego.
Quat.—San Pedro.

Hemimactra lenticularis Gabb.

Mioc.—Martinez, Contra Costa County; Griswold's, San Benito County.

Hemimactra occidentalis Gabb.

Mioc.—Martinez, Contra Costa County.

Hinnites giganteus Gray.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Santa Rosa Island, Santa Barbara County; Ventura County; Los Angeles County.
Mioc.—Siebeck's, Santa Clara County.

Hipponyx antiquatus Linnæus.

L.—Bodega and south; South America; Atlantic.
Quat.—San Pedro.

Hipponyx cranioides Carpenter.

L.—Straits of Fuca to Santa Barbara.
Quat.—Santa Barbara.

Idmonea californica Conrad.

L.? *Quat.*—Santa Barbara.

Ischnochiton magdalensis Hinds.

L.—Monterey to San Diego; Lower California.
Quat.—Santa Barbara.

Janira bella Conrad.

Pl.—Santa Barbara.

Janira dentata Sowerby.

L.—West tropical America.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Janira florida Hinds.

L.—Monterey to Lower California.
Pl.—San Diego well.

Lacuna solidula Loven.

L.—Alaska to San Diego; Norway; circumpolar?
Quat.—Santa Barbara to San Diego.

Lacuna vincta Montagu.

L.—Straits of Fuca; Washington Territory; North Atlantic; circum polar?
Quat.—San Diego.

Laqueus californicus Koch.

L.—Catalina Island; Kamtschatka.
Quat.—Santa Barbara to San Diego.

Lasea rubra Montagu.

L.—Straits of Fuca to San Pedro; circumpolar.
Quat.—Santa Barbara.

Lazaria subquadrata Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara.

Leda cælata Hinds.

L.—Bodega Bay to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—San Fernando, Los Angeles County; San Diego well.
Mioc.—Walnut Creek, Contra Costa County; Griswold's, San Benito County; San Juan Capistrano, San Diego County.

Leda cuneata Sowerby.

L.—Monterey to San Diego; Peru.
Quat.—Santa Barbara.

Leptothyra bacula Carpenter.

L.—Monterey to Catalina Island.
Quat.—Santa Barbara to San Pedro.

Leptothyra paucicostata Dall.

L.—Santa Cruz to Monterey.
Quat.—Santa Barbara.

Leptothyra sanguinea Carpenter.

L.—Straits of Fuca to San Diego; Japan; Europe?
Quat.—Santa Barbara.

Lichenopora californica Conrad.

L.? Quat.—Santa Barbara.

Lima dehiscens Conrad.

(*L.* orientalis *Adams?* China.)
L.—Monterey to San Diego.
Pl.—Santa Barbara.

Limnophysa bulimoides Lea.

L., *F.*—Washington Territory to San Diego, California; Idaho to Nevada.
Quat.—Lahontan Basin, Lassen County, to Nevada; Oregon.

Limnophysa desidiosa Say.

L., *F.*—Northern United States.
Quat.—Walnut Creek, Contra Costa County.

Limnophysa humilis Say.
(*L. ferruginea* Haldemann.)

L., *F.*—Eastern States to California.
Quat.—Walnut Creek, Contra Costa County; Lahontan Basin (Lassen County) to Nevada.

Limnophysa palustris.
(*L. proxima* Lea.)

L., *F.*—Oregon to Alameda County, California.
Quat.—Walnut Creek, Contra Costa County; Lahontan Basin (Lassen County) to Utah (var. *sumassi*, etc.).

Lingula albida Hinds.

L.—Santa Barbara to San Diego; Lower California.
Pl.—San Diego well.

Liocardium elatum Sowerby.

L.—San Pedro to San Diego; Mazatlan.
Quat.—San Pedro.

Liocardium substriatum Conrad.

L.—Monterey to San Diego; South America.
Quat.—Santa Barbara; San Pedro; San Diego.

Liropecten crassicardo Conrad.

Pl.—Kirker's Pass, Contra Costa County; Santa Barbara; Ojai Valley, Ventura County.
Mioc.—Estrella, San Luis Obispo County.

Liropecten estrellanus Conrad.

Mioc.—Estrella, San Luis Obispo County; Santa Rosa Island.

Liropecten veatchii Gabb.

Quat.—Cerros Island, Lower California.
Pl.—Ojai Valley, Ventura County.

Liropecten volæformis Conrad.

L.—West Coast of Mexico. (*L. subnodosus?*)
Pl.—Mountains of San Benito County.
Mioc.—Alameda County; Santa Clara County; Estrella, San Luis Obispo County.

Litorina planaxis Nuttall.

L.—Sitka; San Diego.
Quat.—San Nicolas Island; San Diego.

Litorina remondii Gabb.

Pl.—Kirker's Pass, Contra Costa County.

Litorina scutulata Gould.

(*L. plena* Gould.)

L.—Monterey to San Diego.
Quat.—San Pedro to San Diego.

Lucina borealis Linnæus.

(*L. acutilineata* Conrad.)

L.—Catalina Island, North Atlantic; Asia.
Quat.—Santa Barbara to San Diego.
Pl.—Santa Rosa, Sonoma County; Santa Cruz; Sargent's, Santa Clara County; Santa Barbara; San Fernando; Los Angeles County; San Diego well.
Mioc.—Oregon; Martinez, Contra Costa County; Griswold's, San Benito County; Orestimba Cañon, Stanislaus County; Foxin's; Santa Barbara County.

Lucina californica Conrad.

L.—Santa Cruz to San Diego.
Quat.—Santa Barbara; San Pedro.

Lucina estrellana Conrad. (Not ident.)

"*Mioc.*—Estrella, San Luis Obispo County."

Lucina nuttalli Conrad.

L.—Monterey to San Diego.
Quat.—Santa Barbara; San Pedro.

Lucina permacra Conrad. (Not ident.)

"*Mioc.*—Santa Monica, Los Angeles County."

Lucina richthofeni Gabb.

Pl.—San Fernando, Los Angeles County.

Lucina tenuisculpta Carpenter.

L.—Straits of Fuca to Catalina Island; Mazatlan.
Pl.—San Diego well.

Lunatia lewisii Gould.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara; San Pedro and San Nicolas Islands.
Pl.—Kirker's Pass; Contra Costa County; Santa Barbara; San Fernando, Los Angeles County.

Lunatia pallida Broderip and Sowerby.

L.—Alaska to Catalina Island; circumpolar.
Pl.—Eagle Prairie, Humboldt County; Santa Cruz.

Luponia spadicea Swainson.

L.—Santa Barbara to San Diego, and Lower California.
Quat.—Santa Barbara Island.

Lutricola alta Conrad.

L.—Santa Barbara to San Diego.
Quat.—San Pedro.
Pl.—Santa Barbara; San Fernando, Los Angeles County.
Mioc.—Monterey; El Toro Ranch, Monterey County.

Lutricola viridotincta Carpenter.

L.—Cape St. Lucas, Lower California.
Quat.—Santa Barbara; San Diego.

Lutraria transmontana Conrad. (Not ident.)

"*Pl.*—Los Angeles County." (Like *Reata undulata* Gould.)
L.—San Pedro, Cal.; La Paz, Gulf of California.

Machæra patula Dixon.

L.—Alaska to San Diego; Kamtschatka; Japan.
Pl.—Eagle Prairie, Humboldt County; Santa Rosa, Sonoma County; Twelve-Mile House, San Mateo County; Soquel, Santa Cruz County.
Mioc.—Oregon; Tomales, Marin County; Martinez; Walnut Creek, Contra Costa County; Foxin's, Santa Barbara County; San Emidio Cañon, Kern County.

Macoma calcarea Chemnitz.

L.—Alaska to Santa Barbara; Arctic Ocean.
Quat.—Santa Barbara; San Pedro. *Pliocene?*

Macoma edulis Nuttall.
(*M. secta*, var. Conrad?)

L.—Straits of Fuca to Bolinas Bay; Japan.
Quat.—Santa Barbara; San Pedro.
Pl.—Eagle Prairie, Humboldt County; Santa Rosa, Sonoma County; Twelve-mile House, San Mateo County.
Mioc.—Walnut Creek, Contra Costa County.

Macoma expansa Carpenter.

L.—Straits of Fuca.
Quat.—Santa Barbara; San Pedro.
Pl.—Eagle Prairie, Humboldt County; San Fernando, Los Angeles County; San Diego well.
Mioc.—El Toro Ranch, Monterey County.

Macoma indentata Carpenter.

L.—Monterey to San Diego.
Quat.—San Diego.
Mioc.—El Toro Ranch, Monterey County; Griswold's, San Benito County.

Macoma inquinata Deshayes.

L.—Alaska to San Diego.
Quat.—Monterey to San Diego.
Pl.—Twelve-mile House, San Mateo County; San Fernando, Los Angeles County.

Macoma nasuta Conrad.

L.—Alaska to San Diego; Kamtschatka.
Quat.—Santa Barbara to San Diego.
Pl.—Eagle Prairie and Danger Creek, Humboldt County; Santa Rosa, Sonoma County; San Fernando, Los Angeles County.
Mioc.—Suñol, Alameda County; Foxin's, Santa Barbara County.

Macoma ocoyana Conrad. (Not ident.)

"*Mioc.*—Ocoya Creek" (Posa Creek), Kern County.

Macoma pedroana Conrad. (Not ident.)

"*Quat.*—San Pedro." (Like *M. gemma* Gould, of Mexico.)

Macoma secta Conrad.

L.—Bodega Bay to San Diego; Japan.
Quat.—Santa Barbara to San Diego.
Pl.—Santa Barbara; San Fernando, Los Angeles County.

Macoma yoldiformis Carpenter.

L.—Straits of Fuca to San Pedro.
Quat.—Santa Barbara.

Mactra gabiotensis Conrad. (Not ident.)

"*Mioc.*—Gabiota Pass, Santa Barbara County." (Like *Mulinia angulata*, Gray, of west tropical America.)

Mamma nana Müller.

L.—Alaska; circumpolar.
Quat. and *Pl.*—San Diego; Japan.

Mangelia tabulata Carpenter.

L.—Neah Bay, Washington Territory.
Quat.—Santa Barbara.
Pl.—San Diego well.

Mangelia variegata Carpenter.

L.—Monterey to San Diego.
Quat.—Santa Barbara.

Margarita acuticostata Carpenter.

L.—Bodega Bay to Santa Barbara.
Quat.—Santa Barbara; San Pedro.

Margarita cidaris A. Adams.

L.—Neah Bay, Washington Territory; Japan?
"*Quat.*—San Marcial" (Santa Barbara County?), Carpenter.

Margarita pupilla Gould.

(*M. salmonea* Carpenter.)

L.—Alaska to Catalina Island.
Quat.—Santa Barbara.

Margaritana margaritifera Linnæus.

(*M. falcata* Gould.)

L., *F.*—Circumpolar, south to Santa Cruz and Merced Counties; Arizona.
Quat.—Lahontan Basin (Lassen County), and Walker River Cañon, Nevada.

Marginella jewettii Carpenter.

L.—Monterey to Santa Barbara.
Quat.—San Pedro.

Martesia intercalata Carpenter.

L.—Farallone Islands to Mazatlan.
Quat.—Santa Barbara.

Melampus olivaceus Carpenter.

L.—Salinas River, Cal., to Mazatlan.
Quat.—San Diego.
Pl.—San Diego well.

Membranipora californica Gabb and Horn.

L.? Quat. Santa Barbara.

Membranipora barbarensis Gabb and Horn.

L.? Quat.—Santa Barbara.

Mera gouldii Hanley.

L.—San Diego; Cerros Islands, Lower California.
Quat.—San Diego.

Mera modesta Carpenter.

L.—Straits of Fuca, Washington Territory.
Quat.—San Diego.
Pl.—San Diego well.

Mera obtusa Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara.

Mercenaria perlaminosa Conrad.
(= *M. kennerleyi?* Carpenter.)

L.—Straits of Fuca to Monterey.
Quat.—Santa Barbara.

Meretrix decisa Conrad. (Not ident.)

"*Mioc.*—Ocoya Creek" (Posa Creek), Kern County.

Meretrix traskii Conrad.

Mioc.—Martinez, Contra Costa County; Monterey.

Meretrix tularana Conrad. (Not ident.)

"*Mioc.*—San Emidio Cañon, Kern County."

Meretrix uniomeris Conrad. (Not ident.)

"*Mioc.*—Tres Pinos," San Benito County.

Metula remondii Gabb.

Mioc.—Tomales Bay, Marin County.

Mitra maura Swainson.

L.—Farallone Islands to San Diego; South America.
Quat.—Santa Barbara to San Diego; San Nicolas Island.

Mitromorpha aspera Carpenter.

L.—Monterey, California.
Quat.—Santa Barbara.

Menetus opercularis Gould.

L., *F.*—Straits of Fuca, Washington Territory, to Carmel River, Monterey County; Nevada; Utah.
Quat.—Lahontan Basin (Lassen County); Nevada; Walnut Creek, Contra Costa County.

Modiola capax Conrad.

L.—Santa Barbara to Sån Diego; Lower California and Mexico.
Quat.—Santa Barbara.
Pl.—Santa Barbara.

Modiola contracta Conrad. (Not ident.)

Like *M. multiradiata* Gabb.
"*Mioc.*—Sixteen miles south of Tres Pinos, San Benito County."

Modiola multiradiata Gabb.

Pl.—Eagle Prairie, Humboldt County; Kirker's Pass, Contra Costa County.
Mioc.—Martinez, Walnut Creek, Contra Costa County; El Toro Ranch, Monterey County; San Emidio Cañon, Kern County.

Modiola recta Conrad.

L.—Santa Cruz to San Diego.
Quat.—San Pedro.
Pl.—Santa Rosa, Sonoma County; Twelve-Mile House, San Mateo County; Soquel, Santa Cruz County; San Fernando, Los Angeles County; San Diego well.
Mioc.—El Toro Ranch, Monterey County; Foxin's, Santa Barbara County.

Monoceros engonatum Conrad.

L.—Baulines Bay to San Diego.
Quat.—San Pedro; San Diego.

Monoceros lugubris Sowerby.

L.—West Mexico to South America.
Quat.—Santa Barbara Island.

Morrisia hornii Gabb.

Quat.—Santa Barbara.

Mulinia densata Conrad.

Mioc.—Martinez, San Pablo, Walnut Creek, Contra Costa County; and mountains south to San Emidio Cañon, Kern County.

Muricidea foveolata Hinds.

L.—Baulines Bay to Lower California.
Quat.—Santa Barbara; San Pedro.

Muricidea paucivaricata Gabb.

Quat.—Santa Barbara; San Diego.

Muricidea perita Hinds.

L.—Santa Barbara to Lower California.
Quat.—Santa Barbara.

Mya montereyana Conrad. (Not ident.)

"*Mioc.*—Monterey."
(Like *Periploma argentaria* Conrad, *L.*—San Pedro to San Diego.)

Mya subsinuata Conrad. (Not ident.)

"*Mioc.*—Monterey."
(Like *Macoma inquinata* Deshayes.)

Mytilimeria nuttalii Conrad.

L.—Straits of Fuca to San Diego.
Quat.—San Pedro.
Mioc.—Tomales, Marin County.

Mytilus californianus Conrad.

L.—Straits of Fuca to San Diego; Queen Charlotte's Island.
Quat.—Santa Barbara.
Pl.—San Fernando, Los Angeles County.

Mytilus edulis Linnæus.

L.—Monterey, north; Japan; circumpolar.
Quat.—Benicia, Solano County.

Mytilus inezensis Conrad (Not ident.)

"*Mioc.*—Santa Inez Mountains, Santa Barbara County."

Mytilus mathewsonii Gabb.

Mioc.—Martinez, Contra Costa County; Monterey; San Luis Obispo; San Emidio Cañon, Kern County; Santa Monica, Los Angeles County.

Mytilus pedroanus Conrad. (Not ident.)

"*Quat.*—San Pedro."
(Probably a variety of *M. californianus* Conrad.)

Myurella simplex Carpenter.

L.—Santa Barbara to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Myurella specillata Hinds

L.—San Pedro to Lower California.
Quat.—San Diego.
Pl.—San Diego well.

Nassa fossata Gould.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Danger Creek, Humboldt County; Russian River, Santa Rosa, Sonoma County; Twelve-Mile House, and Seven-Mile Beach, San Mateo County; west of San José, Santa Clara County; Soquel, Santa Cruz County; San Diego well.
Mioc.—Martinez, Walnut Creek, Contra Costa County; Griswold's, San Benito County; Foxin's, Santa Barbara County.

Nassa insculpta Carpenter.

L.—Catalina Island, California.
Quat.—Santa Barbara.

Nassa mendica Gould.

(*N. cooperi* Forbes.)

L.—Sitka to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Kirker's Pass, Contra Costa County; Twelve-Mile House, San Mateo County; San Diego well.

Nassa perpinguis Hinds.

L.—San Francisco Bay to San Diego; Margarita Bay, Lower California.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.
Mioc.—Santa Monica and Alisos Creek, Los Angeles County.

Nassa tegula Reeve.

L.—Santa Barbara to San Diego, Lower California.
Quat.—Santa Barbara to San Diego.

Natica clausa Broderip and Sowerby.

L.—Alaska; Kamtschatka, North Atlantic.
Quat.—Santa Barbara to San Diego.

Natica geniculata Conrad. (Not ident.)

"*Mioc.*—Ocoya Creek" (Posa Creek), Kern County. (Like *Agasoma gravida*, Gabb.)

Neptunea altispira Gabb.

Pl.—Eagle Prairie, Humboldt County; Santa Barbara.

Neptunea humerosa Gabb.

Pl.—San Fernando, Los Angeles County.

Neptunea recurva Gabb.

Mioc.—Tomales, Marin County; Griswold's, San Benito County; El Toro Ranch, Monterey County; Foxin's, Santa Barbara County.

Neverita callosa Gabb.

Mioc.—Walnut Creek, Contra Costa County; Griswold's, San Benito County; Santa Rosa Island.

Neverita recluziana Petit.

L.—Monterey to Lower California.
Quat.—Santa Barbara to San Diego.
Pl.—Santa Barbara; San Fernando, Los Angeles County; San Diego well.
Mioc.—Martinez; Walnut Creek, Contra Costa County; Santa Inez, Santa Barbara County; Santa Monica, Los Angeles County; Posa Creek, Kern County; Death Valley, Inyo County.

Nitidella gouldii Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—San Pedro to San Diego.

Nitidella chrysalloidea Carpenter.

L.—San Pedro and San Diego.
Quat.—Santa Barbara.

Nucula exigua Sowerby.

L.—Catalina Island to South America.
Pl.—San Diego well.

Ocinebra interfossa Carpenter. (And varieties.)

L.—Sitka to San Diego.
Quat.—Santa Barbara.

Ocinebra lurida Middendorf.

(*O. var. aspera* Baird.)

L.—Sitka to Santa Barbara.
Quat.—Santa Barbara; San Pedro.
Pl.—San Diego well.

Odostomia gravida Gould.

L.—Bodega Bay to San Diego.
Quat.—San Pedro; San Diego.

Odostomia straminea Carpenter.

L.—Monterey to Lower California.
Quat.—San Diego.
Pl.—San Diego well.

Olivella biplicata Sowerby.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Seven-Mile Beach, and Twelve-Mile House, San Mateo County; Kirker's Pass, Contra Costa County; San Diego well.

Olivella boetica Carpenter.

L.—Sitka to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Danger Creek, Humboldt County; San Diego well.

Olivella intorta Carpenter.

L.—Bodega Bay to Monterey; Gulf of California.
Quat.—San Pedro; San Diego.
Pl.—San Diego well.

Omphalius fuscescens Philippi.

L.—Catalina Island to San Diego.
Quat.—San Pedro.

Opalia anomala Stearns.

Quat.—San Diego.
Pl.—San Diego well.

Opalia borealis Gould.

L.—Straits of Fuca to San Diego; Kamtschatka.
Quat.—Santa Barbara.

Opalla crenatoides var. (?) insculpta Carpenter.

L.—Santa Cruz to Santa Barbara.
Quat.—Santa Barbara.

Opalia varicostata Stearns.

Quat.—San Diego.
Pl.—San Diego well.

Ostrea attwoodii Gabb.

Pl.?—San Benito County.

Ostrea bourgeoisii Remond.

Pl.—Kirker's Pass, Contra Costa County; Santa Anna Mountains, Los Angeles County.

Ostrea conchaphila Carpenter.

L.—Catalina Island to Panama.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Ostrea heermanni Conrad.

Pl.—West of Colorado Desert, San Diego County?

Ostrea lurida Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—Benicia, Solano County; San Diego.

Ostrea panzana Conrad. (Not ident.)

"*Mioc.*—Panza Valley, Santa Inez Mountains," Santa Barbara County; "Estrella," San Luis Obispo County.

Ostrea subjecta Conrad. (Not ident.)

"*Mioc.*—Santa Monica Mountains." (Like *O. titan* Conrad, young.)

Ostrea titan Conrad.

(*O. virginica* var. *californica* Marcose, fragments.)

Mioc.—Kirker's Pass, Contra Costa County, and throughout Upper Miocene of the Coast Ranges to Lower California.

Ostrea tayloriana Gabb.

(*O. titan* Conrad, young?)

Mioc.—San Marcos Pass, Santa Barbara County; San Juan Capistrano, Los Angeles County.

Ostrea veatchii Gabb.

Pl.—Santa Rosa Island; Lower California; San Diego well.

Ostrea vespertina Conrad.

Pl.—Santa Barbara, San Fernando, Los Angeles County; west of Colorado Desert, San Diego County.

Pachydesma crassatelloides Conrad.

L.—Santa Cruz to San Diego.
Quat.—Santa Barbara to San Diego.

Pachydesma inezana Conrad.

Mioc.—Santa Inez Mountains, Santa Barbara County.

Pachypoma biangulata Gabb.

Mioc.—Martinez, Contra Costa County.

Pachypoma gibberosum Chemnitz.

L.—Straits of Fuca to Catalina Island; New Zealand?
Quat.—Santa Barbara; San Pedro.

Pandora bilirata Conrad. (Not ident.)

Quat.—Santa Barbara. (Like *Kennerlia bicarinata* Carpenter, Catalina Island.)

Pandora scapha Gabb.

Mioc.—Martinez, Contra Costa County.

Parapholas californica Conrad.

L.—Baulines Bay to San Diego.
Quat.—Santa Barbara.

Pecten æquisulcatus Carpenter.

(*P. ventricosus*, var.?)
L.—Monterey to San Diego.
Quat.—San Diego.

Pecten catilliformis Conrad.

Mioc.—Oregon; Walnut Creek, Contra Costa County; Ocoya (Posa) Creek, Kern County; Alisos Creek, Los Angeles County.

Pecten deserti Conrad. (Not ident.)

"*Pl.*—West of Colorado Desert; San Diego County;" near San Diego?

Pecten discus Conrad. (Not ident.)

"*Mioc.*—Santa Inez Mountains, Santa Barbara County."

Pecten hastatus Sowerby.

(*P. altiplicatus* Conrad.)

L.—Sitka to Santa Barbara.
Quat.—Santa Barbara to San Diego.
Pl.—Santa Barbara; San Fernando, Los Angeles County; San Diego well.
Mioc.—Estrella, San Luis Obispo County; San Rafael hills, Santa Barbara County.

Pecten hemphilli Dall.

Pl.—San Diego.

Pecten islandicus Müller.

L.—Arctic Seas; circumpolar.
Quat.—Santa Barbara; San Diego.
Pl.—San Diego.

Pecten latiauritus Conrad.

(*P. monotimeris* Conrad.)

Quat.—Santa Barbara; San Pedro.

Pecten magnolia Conrad. (Not ident.)

"*Mioc.*—Santa Inez Mountains, Santa Barbara County."

Pecten meekii Conrad. (Not ident.)

"*Mioc.*—San Rafael hills, Santa Barbara County."

Pecten nevadanus Conrad. (Not ident.)

Mioc.—Ocoya (Posa) Creek, Kern County; San Juan Capistrano, Los Angeles County?

Pecten pabloensis Conrad.

Pl.—Lobitas, San Mateo County; Alisos Creek, Kern County.
Mioc.—Martinez, San Pablo, Contra Costa County; Suñol, Alameda County; El Toro Ranch, Monterey County; Foxins, Santa Barbara County; Point Mogu, Ventura County; San Juan Capistrano, Los Angeles County.

Pecten paucicostatus Carpenter.

L.—Santa Barbara to San Diego.
Quat.—San Diego.

Pecten peckhami Gabb.

Mioc.—San Pablo, Contra Costa County; Monterey County; Ojai Valley, Ventura County.

Pecten pedroanus Trask.

Mioc.—San Pedro (May be an Aucella and cretaceous).

Pecten propatulus Conrad.
(*P. caurinus* Gould; see *Amusium.*)

Mioc.—Oregon; Eel River, Humboldt County; Tomales, Marin County; Walnut Creek, Contra Costa County; Sunol, Alameda County; Griswolds, San Benito County.

Pecten stearnsii Dall.

Pl.—San Diego.

Pecten ventricosus Sowerby.

L.—West tropical America.
Quat.—San Pedro; San Diego.
Pl.—San Diego well.

Periploma argentaria Conrad.

L.—San Pedro to San Diego.
Quat.—San Diego.

Perna montana Conrad. (Not ident.)

"*Mioc.*—San Buenaventura," Ventura County.

Petricola carditoides Conrad.

L.—Sitka to San Diego.
Quat.—San Pedro to San Diego.

Phasianella compta Gould.

L.—San Pedro to Mazatlan.
Quat.—San Pedro; San Diego.

Phidolopora labiata Gabb & Horn.

L.? *Quat.*—Santa Barbara.

Pholadidea ovoidea Gould.

L.—Baulines Bay to San Diego.
Quat.—Santa Barbara to San Diego.

Pholadidea penita Conrad.

L.—Straits of Fuca to Santa Barbara.
Quat.—Santa Barbara.

Phorcus pulligo Martyn.

L.—Sitka to San Pedro.
Quat.—San Diego.

Physa ampullacea Gould.

L., *F.*—Lake Osoyoos, latitude 49°, Washington Territory, to Owens River, California.
Quat.—Mono Basin, Mono County.

Physa diaphana Tryon.

L., *F.*—Northern California.
Quat.—Walnut Creek, Contra Costa County.

Physa humerosa Gould.

L., *F.*—Pyramid Lake, Nevada; Colorado River, California; Pecos River, Texas.
Quat.?—Near Carson, Nevada, to Colorado Desert.

Pinna alamadensis Yates.*

Mioc.—Alameda County.

Pinna venturensis Yates.†

Pl.—Casitas Pass, Ventura County.

---

* **Pinna alamadensis** Yates. This species has nine concentric inequidistant rounded wrinkles emanating from the open side, and turning toward the hinge at nearly right angles, the entire shell marked by small longitudinal narrow ribs (about forty), which, radiating from the apex, extend to the basal margin, becoming more indistinct as they approach the lower margin. These ribs at their intersections with the lines of growth are ornamented by slight elevations forming zigzag markings along the lines of growth. The hinge side is straight the entire length, the opposite side running parallel for about one half the distance from base to apex, where it makes a sharp curve, thence at an angle of about forty-five degrees to the apex. Length nine, width five, and thickness about two inches. Locality, Alameda Creek, Alameda County. Only one specimen found, and that a very fine one, in the center of a round sandstone bowlder. Miocene.

† **Pinna venturensis** Yates. From the hinge side about two thirds of the width of this shell is marked by nine well developed, narrow ribs, radiating from the apex to the basal margin; the other portion shows rounded, concentric inequidistant ribs extending only to the line of the radiating ribs, so that about two thirds of the surface is covered by the radiating smaller ribs, and one third by the curved, concentric, rounded ribs or wrinkles, very like Pinna pectinata, figured in "Brown's Recent Conchology." Pinna venturense is short and thick compared with its length. The largest specimen found was about five and one half inches long, three and one half in width, and one and three fourths in thickness, the hinge side considerably shorter than the other. Locality, several specimens collected by the writer in Casitas Pass, Ventura County. Pliocene.—*L. G. Yates.*

Pisania fortis Carpenter.

Quat.—Santa Barbara.

Pisidium compressum Prime.

L., F.—California; North Atlantic States; Utah; Nevada.
Quat.—Lahontan Basin, Lassen County (?), California, to Walker River Cañon, Nevada.

Pisidium occidentale Newcomb.

L., F.—Brooks and ponds, sea level to 7,200 feet altitude, California.
Quat.—Walnut Creek, Contra Costa County.

Pisidium ultramontanum Prime.

L., F.—Canoe Creek, Pit River, Shasta County (to Clear Lake, Lake County?; near *P. compressum*), Oregon.
Quat.—Lahontan Basin, Lassen County, California (?), to Truckee Valley, Nevada.

Placunanomia macroschisma Deshayes.

L.—Unalaska to San Diego; Japan.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Planorbis subcrenatus Carpenter.

L., F.—Vancouver Island, and Washington Territory; Oregon to Northern California; Honey Lake, Lassen County.
Quat.—Walnut Creek, Contra Costa County.

Platyodon cancellatus Conrad.

L.—Baulines Bay to San Diego.
Quat.?—Santa Cruz.

Pleurotoma perversa Gabb.

L.—Vancouver Island to Catalina Island.
Quat.—Santa Barbara to San Pedro.

Pleurotoma transmontana Conrad. (Not ident.)

" *Mioc.*—Ocoya (Posa) Creek, Kern County."

Pomaulax undosus Wood.

L.—Santa Barbara to Cape Saint Lucas; Monterey?
Quat.—Santa Barbara to San Diego.

Pompholyx effusa Lea.

L., F.—Dalles, Oregon, to Tehama, California; Carson River to White Pine, Nevada.
Quat.—Lahontan Basin, Lassen County, and Nevada.

Priene oregonensis Redfield.

L.—Straits of Fuca to Monterey; Japan.
Quat.—Santa Barbara; San Pedro.

Psephis lordi Baird.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara.

Psephis salmonea Carpenter.

L.—Catalina Island.
Quat.—Santa Barbara.

Psephis tantilla Gould.

L.—Straits of Fuca to Catalina Island.
Quat.—Santa Barbara.

Pseudocardium gabbii Remond.

Pl.—Kirker's Pass, Contra Costa County.
Mioc.—Martinez, Contra Costa County; Cerro Bonito, Monterey County.

Pteronotus festivus Hinds.

L.—San Pedro and San Diego; Lower California.
Quat.—Santa Barbara; San Diego.

Puncturella cucullata Gould.

L.—Straits of Fuca to Monterey.
Quat.—Santa Barbara; San Pedro.

Pupilla muscorum Linnæus.

L., T.—Circumpolar; Truckee Valley, Nevada.
Quat.—Lahontan Basin, Lassen County (?), California; Rye Patch, Nevada.

Purpura canaliculata Duclos.

L.—Alaska to Monterey.
Quat.—Santa Barbara.
Pl.—Danger Creek, Humboldt County; Kirker's Pass, Contra Costa County; Twelve-Mile House, San Mateo County.

Purpura crispata Chemnitz.

(Var. *septentrionalis* Reeve.)

L.—Sitka to Santa Barbara.
Quat.—Santa Barbara to San Diego.
Pl.—Seven-Mile Beach, San Mateo County.

Purpura (Stramonita) petrosa Conrad. (Not ident.)

"*Mioc.*—Tulare County" (Siebeck's, Santa Clara County?). Like *Monoceros lugubre* Sowerby.

Purpura saxicola Valenciennes.

(*Var. ostrina* Gould.)

L.—Alaska to San Diego; Lower California.
Pl.—Santa Rosa, Sonoma County; Kirker's Pass, Contra Costa County; San Fernando, Los Angeles County.

Ranella mathewsonii Gabb.

Quat.?—Santa Barbara.
Pl.—Santa Barbara; San Diego well.
Mioc.—Martinez, Contra Costa County.

Ranella muriciformis Broderip.

L.—West coast of Mexico, and south.
Quat.—San Diego.

Ranella triquetra Carpenter.

L.—West coast of Mexico.
Quat.—San Diego.

Reptescharella heermanni Gabb & Horn.

L.? and Quat.—Santa Barbara.

Reptescharella plana Gabb & Horn.

L.? and Quat.—Santa Barbara.

Reptescharellina cornuta Gabb & Horn.

L.? and Quat.—Santa Barbara.

Reptescharellina disparilis Gabb & Horn.

L.? and Quat.—Santa Barbara.

Reptescharellina heermanni Gabb & Horn.

L.? and Quat.—Santa Barbara.

Reptoporina eustomata Gabb & Horn.

L., *Quat.*—Santa Barbara.

Rissoina woodwardi Carpenter.

L.—West coast of Mexico; Gulf of California.
Quat.—San Diego.

Rupellaria lamellifera Conrad.

L.—Farallone Islands to San Diego.
Quat.—Santa Barbara.
Pl.?—Monterey.

Saxicava abrupta Conrad. (Not ident.)

"*Quat.*—San Pedro." (Like *Petricola carditoides* Conrad, living.)

Saxicava pholadis Linnæus.

L.—Alaska to Santa Barbara. Universal?
Quat.—Santa Barbara.

Saxidomus gibbosus Gabb.

Pl.—Eagle Prairie, Humboldt County.

Saxidomus gracilis Gould.
(*S. aratus* Gould.)

L.—Baulines Bay to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Kirker's Pass, Contra Costa County; Twelve-Mile House, San Mateo County; Santa Barbara; San Fernando, Los Angeles County.
Mioc.—Martinez; Walnut Creek, Contra Costa County; Santa Cruz; Santa Inez, Santa Barbara County; Santa Monica, Los Angeles County.

Saxidomus nuttalli Conrad.

L.—Sitka to San Diego; Japan?
Quat.—Santa Barbara; San Pedro.
Pl.—Santa Barbara.

Scalaria bellastriata Carpenter.

L.—San Pedro to San Diego.
Quat.—Santa Barbara.

Scalaria crebricostata Carpenter.

L.—Monterey to San Diego.
Quat.—Santa Barbara; San Pedro.

Scalaria hemphilli Dall.

Quat.—San Diego.
Pl.—San Diego well.

Scalaria indianorum Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara; San Diego.

Scalaria subcoronata Carpenter.

L.—Bodega Bay to San Diego.
Quat.—Santa Barbara; San Pedro.
Pl.—San Diego well.

Scalaria tincta Carpenter.

L.—Santa Cruz to San Diego.
Quat.—San Diego.
Pl.—San Diego.

Schizodesma abscissa Gabb.

Mioc.—Martinez, San Pablo, Walnut Creek, Contra Costa County.

Schizothoerus nuttalli Conrad.

L.—Alaska to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Santa Barbara.

Semele decisa Conrad.

L.—Santa Barbara to San Diego.
Quat.—San Pedro.

Semele pulchra Sowerby.

L.—Santa Barbara to San Diego; Acapulco to South America.
Quat.—San Pedro; San Diego.

Semitubigera tuba Gabb & Horn.

L.? Quat.—Santa Barbara.

Septifer bifurcatus Reeve.

L.—Farallone Islands to San Diego.
Quat.—Santa Barbara; San Diego.

Serpulorbis squamigerus Carpenter.

L.—Monterey to San Diego.
Quat.—Santa Barbara to San Diego.

Sigaretus debilis Gould.

L.—Monterey to Lower California; South America.
Pl.—San Diego well.

Sigaretus planicostum Gabb.

Pl.—San Fernando, Los Angeles County.

Siliquaria edentula Gabb.

Pl.—San Fernando, Los Angeles County.

Siphonalia kelletii Forbes.

L.—Santa Barbara to San Diego; Japan.
Quat.—San Pedro to San Diego.

Siphonella multipora Gabb & Horn.

L.? and Quat.—Santa Barbara.

Siphonodentalium lofotense Sars.

L.—Islands of California Coast; Norway.
Pl.—San Diego well.

Siphonodentalium pusillum Gabb.

Pl.—San Diego well.
(*Cret.* or *Eocene?*)—Martinez, Contra Costa County; Tejon, Kern County. (See Cret. list.)

Solarellia peramabilis Carpenter.

L.—Catalina Island, 40 to 120 fathoms deep. (240 to 720 feet.)
Quat.—Dead Man's Island; San Pedro.

Solecurtus californianus Conrad.

(*S. subteres?* Conrad.)

L.—Santa Barbara to San Diego.
Quat.—Santa Barbara; San Pedro; San Diego.
Pl.—San Diego well.

Solen rosaceus Carpenter.

L.—Santa Barbara to San Diego.
Quat.—Santa Barbara.
Pl.—Santa Rosa, Sonoma County; San Ramon, Kirker's Pass, Contra Costa County; San Fernando, Los Angeles County; San Diego well.
Mioc.—Tomales, Marin County; Martinez, Contra Costa County.

Solen sicarius Gould.

L.—Straits of Fuca to San Pedro; Japan.
Pl.—Twelve-Mile Creek, San Mateo County; San Fernando, Los Angeles County.
Mioc.—Walnut Creek, Contra Costa County.

Sphærium dentatum Haldemann.

L., *F.*—Oregon to Idaho; Humboldt River, Nevada, to Utah Lake.
Quat.—Lahontan Basin (Lassen County), to Utah.

Sphærium patella Gould.

(S. *nobile* Gould.)

L., *F.*—Oregon to Southern California (Kern County); Colorado River (?).
Quat.—Near Martinez, Contra Costa County.

Sphærium striatinum Lamarck.

L., *F.*—Hell Gate River, Montana, to Humboldt River, Nevada; Missouri River east to Canada.
Quat.—Lahontan Basin (Lassen County?); Rye Patch, Nevada.

Standella californica Conrad.

(*S. planulata* Conrad.)

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—Kirker's Pass, Contra Costa County; Twelve-Mile House, San Mateo County; Santa Barbara.
Mioc.—Oregon; Martinez, Contra Costa County; Griswold's, San Benito County; Foxins, Santa Barbara County.

Standella falcata Gould.

(*S. nasuta* Gould.)

L.—Kodiak, Alaska, to San Diego.
Quat.—San Diego.
Pl.—Eagle Prairie, Humboldt County; Kirker's Pass, Contra Costa County; Seven-Mile Beach, San Mateo County.
Mioc.—Martinez, Contra Costa County; Half-moon Bay, San Mateo County; Suñol, Alameda County; Siebeck's, Santa Clara County; Griswold's, San Benito County; Foxins, Santa Barbara County; Santiago, Los Angeles County.

Succinea stretchiana Bland.

(*S. gabbii* Tryon.)

L., *T.*—Northeast California, and southeast Oregon.
Quat.—Lahontan Basin, Lassen County (?); Rye Patch, Nevada.

Surcula carpenteriana Gabb.

L.—Monterey to San Diego.
Quat.—Santa Barbara; San Pedro.
Pl.—Santa Rosa, Sonoma County; San Fernando, Los Angeles County; San Diego well.

Surcula tryoniana Gabb.

L.—San Diego.
Pl.—Santa Barbara; San Pedro.

Tamiosoma gregaria Conrad.

Mioc.—Tulare Valley; Estrella; Santa Margarita, San Luis Obispo County; San Juan Capistrano, Los Angeles County.

Tapes inezensis Conrad. (Not ident.)

"*Mioc.*—Santa Inez Mountains, Santa Barbara County." (Like *Saxidomus gracilis* Gould.)

Tapes montana Conrad. (Not ident.)

"*Mioc.*—San Buenaventura." (Like *Amiantis callosa* Conrad.
L.—Santa Barbara to San Diego; Cape St. Lucas.)

Tapes staleyi Gabb.

Pl.—Eagle Prairie, Humboldt County; Santa Rosa, Sonoma County; Kirker's Pass, Contra Costa County; Santa Cruz.

Tapes staminea Conrad. (And varieties.)

L.—Straits of Fuca to San Diego; Margarita Bay; Lower California.
Quat.—Santa Barbara to San Diego.
Pl.—Santa Rosa, Sonoma County; Twelve-Mile House, San Mateo County; Kirker's Pass, Contra Costa County; Monterey; San Fernando, Los Angeles County.
Mioc.—West of San José, Santa Clara County; Foxins, Santa Barbara County. Varieties *diversa* Sowerby, *orbella* Carpenter, and *petitii* Deshhayes, the last northward.

Tapes tenerrima Carpenter.

L.—Straits of Fuca to San Diego.
Quat.—Santa Barbara.
Pl.—Santa Barbara.

Tapes truncata Gabb.

Pl.—San Fernando, Los Angeles County.
Mioc.—Suñol, Alameda County; near Black Mountain, Santa Clara County; Griswold's, San Benito County.

Tellina bodegensis Hinds.

L.—Straits of Fuca to San Diego; Japan.
Quat.—San Pedro to San Diego.
Mioc.—Oregon; Walnut Creek, Contra Costa County.

Tellina congesta Conrad.

Mioc.—San Pablo, Contra Costa County; Monterey to San Diego.

Tellina diegoana Conrad. (Not ident.)

"*Mioc.*—San Diego?"

Thalotia caffea Gabb. (*Ptychostylis.*)

L.—Monterey.
Quat.—Santa Barbara and San Pedro.

Thracia mactropsis Conrad. (Not ident.)

"*Mioc.?*—Monterey County."

Thracia trapezoides Conrad.

Pl.—Eagle Prairie, Humboldt County.
Mioc.—Oregon.

Tornatella elliptica Trask. (Not ident.)

"*Quat.*—Santa Barbara."

Tornatella punctocælata Carpenter.

L.—Santa Cruz to San Diego.
Quat.—Santa Barbara to San Diego.

Tornatina carinata Carpenter.

L.—Santa Barbara to San Diego; Panama.
Quat.—San Diego.
Pl.—San Diego well.

Tornatina cerealis Gould.

L.—Monterey to San Diego.
Quat.—Santa Barbara; San Diego.

Tornatina culcitella Gould.

L.—Monterey to San Diego.
Quat.—Santa Barbara.

Tornatina eximia Baird.

L.—Vancouver Island to San Diego.
Quat.—San Diego.
Pl.—San Diego well.

Triptera clavata Gabb.

Mioc.—Griswold's, San Benito County.

Trochiscus norrisii Sowerby.

L.—Santa Barbara to San Diego; Monterey?
Quat.—Santa Barbara.

Trophon multicostatus Escholtz.

L.—Sitka to Monterey; Greenland.
Quat.—Santa Barbara.

Trophon orpheus Gould.
(*Murex fragilis* Trask ?)

L.—Sitka to Straits of Fuca; Washington Territory.
Quat.—San Pedro; San Diego.
Pl.—San Diego well.

Trophon ponderosus Gabb.

Mioc.—Walnut Creek, Contra Costa County; Griswold's, San Benito County.

Trophon tenuisculptus Carpenter.

Quat.—Santa Barbara.

Trophon triangulatus Carpenter.

L.—Santa Cruz Island to Catalina Island; Lower California?
Quat.—Santa Barbara.

Tryonia clathrata Stimpson.

F., *Quat.*—Colorado Desert, California. (Fossil only?)

Tryonia exigua Conrad.
(*T. protea* Gould.)

L., *F.*—Southern Utah.
Quat.—Colorado Desert, California.

Turbinella cæstus Broderip.

L.—Lower California to Panama.
Pl.?—Santa Rosa Island.

Turritella cooperi Carpenter.

L.—Santa Barbara to San Diego.
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Turritella hoffmani Gabb.

Mioc.—Siebeck's, Santa Cruz Mountains; Sespi Cañon, Ventura County.

Turritella inezana Conrad.

Mioc.—Santa Inez Mountains, Santa Rosa Island, Santa Barbara County; Santa Monica, Los Angeles County.

Turritella jewetti Carpenter.

L.—Santa Barbara; (Jewett, fossil only?)
Quat.—Santa Barbara to San Diego.
Pl.—San Diego well.

Turritella ocoyana Conrad.

Mioc.—Ocoya Creek (Posa Creek), Kern County; Santa Rosa Island, Santa Barbara County; Santa Monica, Los Angeles County.

Turritella variata Conrad.

Mioc.—Santa Monica, Los Angeles County; Najohui Ranch.

Vallonia pulchella Müller.

L., *T.*—Circumpolar, south to latitude 38°, on mountains.
Quat.—Lahontan Basin, Lassen County?; Rye Patch, Nevada.

Valvata virens Tryon.

L., *F.*—Mendocino County to Alameda County; Grant's Lake, Eastern Oregon.
Quat.—Lahontan Basin, Lassen County, to Nevada.
Pl.?—Gelcich's coal mines, Santa Cruz County.

Vanikoro diegoana Conrad. (Not ident.)

"*Mioc.*—San Diego."

Velutina lævigata Linnæus.

L.—Straits of Fuca to Monterey; North Atlantic.
Quat.—Santa Barbara.

Venericardia borealis Conrad.
(Var.? *ventricosa* Gould.)

L.—Alaska to Catalina Island; North Atlantic.
Quat.—Santa Barbara to San Diego.
Pl.—San Fernando, Los Angeles County; Santa Barbara to San Diego.
Mioc.—Oregon; Foxins, Santa Barbara County; Santa Monica, Los Angeles County.

Venus pajoroensis Conrad. (Not ident.)

"*Pl.*—Pajaro River, Gavilan Mountains, Monterey County." (Like *Callista voyi* Gabb.)

Volvula cylindrica Carpenter.

L.—Santa Barbara to San Diego.
Quat.—San Diego.

Volutilithes indurata Conrad.

Pl.—Half-moon Bay, San Mateo County.
Mioc.—Oregon; Tomales Bay, Marin County.

Yoldia impressa Conrad.
(*Y. cooperi* Gabb.)

L.—Santa Cruz to San Diego.
Quat.—San Pedro.
Pl.—San Fernando, Los Angeles County.
Mioc.—Oregon; Martinez; Walnut Creek, Contra Costa County.

Yoldia nasuta Gabb.

Pl.?—Los Angeles.

Yoldia amygdala Valenciennes.

L.—Straits of Fuca to Monterey.
Quat.—Dead Man's Island, San Pedro.

Zirphœa dentata Gabb.

Quat.—Santa Barbara; San Pedro.
Pl.—Kirker's Pass, Contra Costa County.

Zirphœa gabbi Tryon.
(*Z. crispata* Linnæus?)

Quat.—Santa Barbara; San Pedro.
Mioc.?—Alameda County.

TERTIARY RADIATA.

Asterias remondi Gabb.

Mioc.—Star Fish Point, Martinez, Contra Costa County.

Astrodapsis antiselli Conrad.

Mioc.—Near Buena Vista Lake, Kern County.

Astrodapsis tumidus Remond.

Pl.—Kirker's Pass.
Mioc.—Walnut Creek, Contra Costa County.

Astrodapsis whitneyi Remond.

Pl.—Kirker's Pass, Contra Costa County.

Clypeaster gabbi Remond.

Mioc.—Martinez; San Pablo; Walnut Creek, Contra Costa County.

Echinarachnius brewerianus Remond.

Mioc.—San Pablo; Walnut Creek; Mt. Diablo, Contra Costa County.

Echinarachnius excentricus Escholtz.
(*Scutella striatula* Conrad.)

L.—Alaska to San Pedro.
Quat.—San Pedro.
Pl.—Seven-Mile Beach, San Mateo County; San Fernando, Los Angeles County; San Diego.

Scutella interlineata Stimpson.

Pl.—Seven-Mile Beach, San Mateo County.

Scutella gibbsi Remond.

Mioc.—Near Buena Vista Lake, Kern County.

CRETACEOUS (AND EOCENE?)* CRUSTACEA.

Callianassa stinpsoni Gabb.

Cret.—Chico, Butte County; Clayton, Contra Costa County.
B.?—Tejon, Kern County; very probably includes more than one species.

CRETACEOUS (AND EOCENE) MOLLUSCA.

Acmæa tejonensis Gabb.

Cret. B.—Tejon, Kern County.

Actæon impressus Gabb.

Cret.—Cottonwood Creek, Shasta County.

Actæonella oviformis Gabb.

Cret.—Cottonwood Creek, Shasta County; Santa Ana Mountains, Los Angeles County.

---

*Note—The Cretaceous strata of Gabb, are now considered to include the Eocene, though the line of division between them cannot be determined in most parts of California. The name Cretac-eocene has been suggested for the combined series, but to indicate the localities where the Eocene is best defined, the term *Cret. B.* is used as equivalent to Gabb's "Division B."

Actæonina californica Gabb.

Cret.—Near Yreka, Oregon; Benicia, Solano County; Martinez, Contra Costa County.

Actæonina pupoides Gabb.

Cret.—Cottonwood Creek, Shasta County.

Amauropsis oviformis Gabb.

Cret.—Tuscan Springs, Tehama County.

Ammonites (Lytoceras) batesi Trask.

Cret.—Cottonwood Creek, Shasta County; Benicia, Solano County; Mt. Diablo, Contra Costa County.

Ammonites (Haploceras) breweri Gabb.

Cret.—Queen Charlotte's Island, B. C.; Cottonwood Creek, Shasta County; Arroyo Valley, Alameda County.

Ammonites chicoensis Trask.

Cret.—Siskiyou Mountains; Cottonwood Creek, Shasta County; Chico Creek, Kelly's, Pentz's, Butte County; Pacheco's Pass, Merced County; Santa Ana Mountains, Los Angeles County.

Ammonites (Heteroceras) cooperi Gabb.

Cret.—Comox, Vancouver Island; San Diego (old coal mine near Point Loma, from below sea level).

Ammonites fraternus Gabb.

Cret.—Benicia, Solano County; Arroyo Valley, Alameda County.

Ammonites hoffmanni Gabb.

Cret.—Horsetown, Shasta County; Arroya Valley, Alameda County.

Ammonites jugalis Gabb.

Cret.—Benicia, Solano County; Martinez, Mt. Diablo, Contra Costa County.

Ammonites peruvianus Von Buch.

Cret.—Tuscan Springs, Tehama County.

Ammonites ramosus Meek.

Cret.—Cottonwood Creek, Shasta County; Arroyo Valley, Alameda County.

Ammonites remondi Gabb.

Cret.—Cottonwood Creek, Shasta County; Pentz's, Butte County.

Ammonites (Hoplites) stoliczkanus Gabb.

Cret.—Cottonwood Creek, Shasta County.

Ammonites complexus suciensis Meek.

Cret.—Vancouver Island, and Sucia Island, B. C.; Folsom, Sacramento County, and Mt. Diablo.

Ammonites tehamaensis Gabb.

Cret.—Battle Creek, Tehama County.

Ammonites traski Gabb.

Cret.—Cottonwood Creek, Shasta County; Arroya Valley, Alameda County.

Ammonites whitneyi Gabb.

Cret.—Cottonwood Creek, Shasta County.

Ampullina striata Gabb.

Cret.—Martinez, Contra Costa County.

Anatina inæquilateralis Gabb.

Cret.—Siskiyou Mountains.

Anatina lata Gabb.

Cret.—Pentz's Ranch, Butte County.

Anatina tryoniana Gabb.

Cret.—Gabriola Island, B. C.; Martinez, Contra Costa County.

Anchura angulata Gabb.

Cret.—Huling Creek, Shasta County; Martinez, Contra Costa County.

Anchura californica Gabb.

Cret.—Siskiyou Mountains; Chico, Butte County; Martinez; Puerto Cañon, and Orestimba Cañon, Stanislaus County.

Anchura carinifera Gabb.

Cret.—Martinez, Contra Costa County.

Anchura exilis Gabb.

Cret.—Sucia Island, B. C.; Martinez, Contra Costa County.

Anchura falciformis Gabb.

Cret.—Tuscan Springs, Tehama County; Chico, Butte County; Texas Flat, Placer County.

Anchura monilifera Gabb.

Cret.—Santa Ana Mountains, Los Angeles County; Arivechi, Mexico.

Anchura transversa Gabb.

Cret.—Martinez, Contra Costa County.

Ancillaria elongata Gabb.

Cret. B.—Near Mt. Diablo; San Diego.

Ancyloceras lineatus Gabb.

Cret.—Cottonwood Creek, Shasta County; Folsom, Sacramento County.

Ancyloceras percostatus Gabb.

Cret.—Cottonwood Creek, and Arbuckles, Shasta County; Martinez, Contra Costa County.

Ancyloceras quadratus Gabb.

Cret.—Pentz's, Butte County.

Ancyloceras remondi Gabb.

Cret.—Queen Charlotte's Island, B. C.; Cottonwood Creek, and Arbuckles, Shasta County.

Angaria ornatissima Gabb.

Cret.—Hornby and Sucia Islands, B. C.; Tuscan Springs, Tehama County; Texas Flat, Placer County.

Anisomyon meeki Gabb.

Cret.—Vancouver Island, B. C.; Cottonwood Creek, Shasta County.

Anomia lineata Gabb.

Cret.—Chico Creek; Pentz's, Butte County; Texas Flat, Placer County.

Anthonya cultriformis Gabb.

Cret.—Martinez, Contra Costa County.

Arca breweriana Gabb.
(*A. vancouverensis* Meek.)

Cret.—Cottonwood Creek, Shasta County; Tuscan Springs, Tehama County.

Arca decurtata Gabb.

Cret.—Millville, Shasta County; Rag Cañon, Napa County; Alameda County.

Arca gravida Gabo.

Cret.—Rag Cañon, Napa County; Pacheco's Pass, San Benito County.

Arca horni Gabb.

Cret. B.—Tejon, Kern County

Architectonica cognata Gabb.

Cret. B.—Martinez, Clayton, Contra Costa County; Tejon, Kern County.

Architectonica horni Gabb.

Cret. B.—Tejon, Kern County.

Architectonica inornata Gabb.

Cret.—Tuscan Springs, Tehama County; Martinez, Contra Costa County.

Architectonica veatchi Gabb.

Cret.—Tuscan Springs, Tehama County.

Arcomya undulata Gabb.

Cret.—Indian Creek, Butte County.

Asaphis undulata Gabb.

Cret.—Texas Flat, Placer County.

Astarte conradiana Gabb.

Cret.—Sucia Island, British Columbia; Texas Flat, Placer County.

Astarte mathewsoni Gabb.

Cret.—Martinez, Contra Costa County.

Astarte tuscana Gabb.

Cret.—Vancouver and Sucia Islands, B. C.; Tuscan Springs, Tehama County; Pentz's, Butte County; Santa Ana Mountains, Los Angeles County.

Astrocœnia petrosa Gabb.

Cret.—Martinez, Contra Costa County.

Ataphrus crassus Gabb.

Cret.—Martinez, Contra Costa County.

Ataphrus compactus Gabb.

Cret.—Denman Island, B. C.; Texas Flat, Placer County.

Atresius liratus Gabb.

Cret.—Near Hot Sulphur Springs, Colusa County.

Aturia mathewsonii Gabb.

Cret. B.?—Martinez, Clayton, Contra Costa County; Tejon, Kern County.

Aucella piochi Gabb.

Cret.—Queen Charlotte's Island, B. C.; Washington Territory; Colusa County; Knoxville, Lake County; Putah Creek, Solano County; north side of Mount Diablo; south of New Almaden, Santa Clara County. (N. B.—It is believed by Dr. C. A. White, Professor Becker, and others, that at least part of these specimens are identical with *A. erringtoni* Gabb, one of the Jurassic fossils of the Sierra Nevada, and both may be varieties of *A. mosquensis* (Von Buch) of Russia, etc.)

Avicula pellucida Gabb.

Cret.—Siskiyou Mountains; Lower Lake, Lake County; Martinez; Griswold's, San Benito County; Pacheco's Pass, Merced County; Tejon, Kern County. (Perhaps two species of Divisions A and B.)

Axinæa cor Gabb.

Cret. B.—Tejon Pass, Kern County.

Axinæa sagittata Gabb.

Cret. B.—Martinez; Griswold's, San Benito County; Tejon, Kern County.

Axinæa veatchi Gabb.

Cret.—Vancouver Island, British Columbia; Cow Creek, Shasta County; Pentz's Ranch, Butte County; Tuscan Springs, Tehama County; Texas Flat, Placer County; Lower Lake, Lake County; Martinez; Orestimba Cañon, Stanislaus County; Santa Ana Mountains, Los Angeles County; San Diego. (Perhaps two species in Divisions A and B.)

Baculites chicoensis Trask.

Cret.—Vancouver and Sucia Islands, B. C.; Cottonwood Creek, Shasta County; Chico Creek, and Pentz's, Butte County; Martinez; Orestimba Cañon, Stanislaus County; Alameda County; San Diego County.

Baculites occidentalis Meek.

Cret.—Sucia Island, B. C.; Shasta County to Alameda County.

Barbatia morsei Gabb.

Cret. B.—Near San Luis Rey to San Diego.

Bela clathrata Gabb.

Cret. B.—Martinez, Contra Costa County.

Belemnites impressus Gabb.

Cret.—Cottonwood Creek, Shasta County; Colusa County; Mount Diablo, Contra Costa County; Napa County; San Benito County.

Brachysphingus liratus Gabb.

Cret. B.—Martinez, Clayton, Marsh's, Contra Costa County.

Brachysphingus sinuatus Gabb.

Cret. B.—Martinez, Contra Costa County.

Bulla horni Gabb.

Cret. B.—Tejon, Kern County.

Bullia (Molopophorus) striata Gabb.

Cret. B.—Vancouver and other islands, B. C.; Tejon, Kern County.

Calliostoma radiatum Gabb.

Cret.—Texas Flat, Placer County.

Cardita planicosta Lamarck.
(*C. horni* Gabb.)

Cret. B.—Albany, Oregon; Martinez, Clayton, Contra Costa County; Griswold's, New Idria, San Benito County; Tejon, Kern County; San Diego; Eastern States and Europe in eocene strata.

Cardita veneriformis Gabb.

Cret.—Martinez, Contra Costa County.

Cardium (Lævicardium) annulatum Gabb.

Cret.—Martinez, Mount Diablo, Contra Costa County; Orestimba Cañon, Stanislaus County.

Cardium breweri Gabb.

Cret. B.—Martinez, Clayton, Contra Costa County; Griswold's, San Benito County; Tejon, Kern County.

Cardium cooperi Gabb.

Cret. B.—Martinez, Mount Diablo, Contra Costa County; Tejon, Kern County; San Diego.

Cardium (Lævicardium) linteum Conrad.

Cret. B—Tejon, Kern County.

Cardium (Protocardium) placerense Gabb.

Cret.—Texas Flat, Placer County.

Cardium remondianum Gabb.

Cret.—Wright's Gulch, Shasta County.

Cardium (Protocardium) translucidum Gabb.

Cret.—Martinez, Contra Costa County.

Caryatis nitida Gabb.

(*C. plana* Sowerby.)

Cret.—Vancouver and other islands, B. C.; Cow Creek, Tehama County; Chico, Butte County; Martinez, Contra Costa County; Orestimba Cañon, Stanislaus County; Europe; India.

Cerithiopsis alternata Gabb.

Cret. B.—Martinez and east of Mt. Diablo, Contra Costa County.

Chemnitzia planulata Gabb.

Cret.—Pentz's, Butte County.

Chione angulata Gabb.

Cret.—Martinez, Contra Costa County.

Chione varians Gabb.

Cret.—Jacksonville, Oregon; Siskiyou Mountains and Cow Creek, Shasta County; Chico Creek and Pentz, Butte County; Tuscan Springs, Tehama County; Texas Flat, Placer County; Folsom, Sacramento County; Benicia, Martinez, and Mount Diablo, Contra Costa County; Orestimba Cañon, Stanislaus County. (Probably includes more than one species.)

Cinulia mathewsoni Gabb.

Cret.—Martinez, Contra Costa County; Orestimba Cañon, Stanislaus County.

Cinulia obliqua Gabb.

Cret.—Vancouver and other islands, B. C.; Cottonwood Creek, Siskiyou County; Cottonwood Creek, Shasta County; Tuscan Springs, Tehama County; Chico Creek and Pentz, Butte County; Texas Flat, Placer County.

Cinulia rectilabrum Gabb.

Cret.—Millville, Shasta County; Alameda County; Arivechi, Mexico.

Clisoclus dubius Gabb.

(*C. cordatus* Meek and Hayden?)

Cret.—Vancouver and Sucia Islands, B. C.; Tuscan Springs, Tehama County; Chico Creek, Butte County; Texas Flat, Placer County.

Conus horni Gabb.

Cret. B.—Tejon, Kern County.

Conus remondi Gabb.

Cret. B.—Martinez; Mt. Diablo, Contra Costa County; Tejon, Kern County; San Diego.

Coralliochama orcutti White.

Cret.—Wallala, Mendocino County; Todos Santos Bay, Lower California.

Corbula alæormis Gabb.

Cret. B.—Lower Lake, Lake County.

Corbula cultriformis Gabb.

Cret.—Martinez, Contra Costa County.

Corbula horni Gabb.

Cret. B.—Tejon, Kern County.

Corbula parilis Gabb.

Cret. B.—Martinez; Mt. Diablo, Contra Costa County; Griswold's, San Benito County; San Diego.

Corbula primorsa Gabb.

Cret. B.—Corral Hollow, Alămeda County.

Corbula traski Gabb.

Cret.—Hornby Island, B. C.?; Tuscan Springs, Tehama County; Pentz's Ranch, Butte County; Texas Flat, Placer County.

Cordiera microptygma Gabb.

Cret. B.—Tejon, Kern County.

Cordiera mitræformis Gabb.

Cret.—Near Sulphur Springs, Colusa County.

Crassatella compacta Gabb.

Cret.—Martinez, Contra Costa County.

Crassatella grandis Gabb.

Cret. B.—Placer County; Lower Lake, Lake County; Clayton, Contra Costa County; Tejon, Kern County.

Crassatella uvasana Conrad.

Cret. B.—Tejon and Uvas Passes, Kern County; San Diego.

Crioceras latus Gabb.

Cret.—Near Weaverville, Trinity County.

Cucullæa inermis Gabb.

Cret.—Millville, Shasta County; Santa Ana Mountains; Arivechi, Mexico.

Cucullæa mathewsoni Gabb.

Cret.—Lower Lake, Lake County; Martinez, Contra Costa County.

Cucullæa truncata Gabb.

(*C. glabra* Parkinson?)

Cret.—Vancouver Island, B. C.; Jacksonville, Oregon; Siskiyou Mountains; Tuscan Springs, Tehama County; Texas Flat, Placer County; Benicia, Solano County; Martinez, Mt. Diablo, Contra Costa County; Orestimba Cañon, Stanislaus County; Pacheco's Pass, Merced County; Europe?

Cylichna costata Gabb.

Cret.—Pentz's, Butte County; Texas Flat, Placer County; Martinez, Mt. Diablo, Contra Costa County; Tejon, Kern County; San Diego (perhaps two species, in Divisions A and B).

Cylindrites brevis Gabb.

Cret.—Martinez, Contra Costa County.

Cymbophora ashburneri Gabb.

Cret.—Vancouver and other islands, B. C.; Millville, Shasta County; Tuscan Springs, Tehama County; Chico and Pentz's, Butte County; Texas Flat, Placer County; Benicia, Solano County; Martinez, Contra Costa County; Orestimba Cañon, Stanislaus County; Pacheco's Pass, Merced County; Alisos Creek, Kern County.

Cypraea (Luponia) bayerquei Gabb.

Cret. B.—Martinez, Clayton, Contra Costa County; Tejon, Kern County.

Cypraea (Epona) mathewsoni Gabb.

Cret. B.—Martinez, Contra Costa County.

Dentalium cooperi Gabb.

Cret. B.—Vancouver and Hornby Islands, B. C.; Martinez, Mt. Diablo, Contra Costa County; Tejon, Kern County; San Diego.

Dentalium stramineum Gabb.

Cret. B.—Martinez, Mt. Diablo, Contra Costa County; Tejon, Kern County; San Diego.

Diodus tenuis Gabb.

Cret. B.—Corral Hollow, Alameda County.

Diptychoceras lævis Gabb.

Cret.—Cottonwood Creek, Shasta County.

Discohelix leana Gabb.

Cret.—Texas Flat, Placer County.

Donax latus Gabb.

Cret. B.—Ten miles west of Griswold's, San Benito County.

Dosinia elevata Gabb.

Cret. B.—Tejon, Kern County; San Diego.

Dosinia gyrata Gabb.

Cret. B.—Sucia Island, B. C.; Martinez, Mount Diablo, Contra Costa County; Griswold's, San Benito County; Tejon, Kern County; San Diego.

Dosinia inflata Gabb.

Cret.—Chico Creek, Butte County.

Dosinia pertenuis Gabb.

Cret.—Siskiyou Mountains; Santa Ana Mountains, Los Angeles County?

Emarginula radiata Gabb.

Cret.—Texas Flat, Placer County.

Eripachya hoffmanni Gabb.

Cret.—Cottonwood Creek, Shasta County.

Eripachya perforata Gabb.

Cret.—Cottonwood Creek, Shasta County.

Eripachya ponderosa Gabb.

Cret.—Tuscan Springs, Tehama County; Pentz's, Butte County.

Eriphyla umbonata Gabb.

Cret.—Vancouver and Sucia Islands, B. C.; Cow Creek, Shasta County; south of Mount Diablo.

Euspira alveata Conrad.

Cret. B.—Lower Lake, Lake County; Martinez, Mount Diablo, Contra Costa County; Griswold's, San Benito County; Tejon, Kern County; San Diego.

Euspira tabulata Gabb.

Cret.—Santa Ana Mountains, Los Angeles County; Arivechi, Mexico.

Exogyra parasitica Gabb.

Cret.—Cottonwood Creek, Shasta County; Texas Flat, Placer County; Folsom, Sacramento County.

Fasciolaria io Gabb.

Cret. B.—Tejon, Kern County.

Fasciolaria læviuscula Gabb.

Cret. B.—Lower Lake, Lake County; Clayton, Contra Costa County.

Fasciolaria sinuata Gabb.

Cret. B.—Tejon, Kern County; San Diego.

Ficopsis cooperi Gabb.

Cret. B.—Clayton, Contra Costa County; San Diego.

Ficopsis horni Gabb.

Cret. B.—Tejon, Kern County.

Ficopsis remondi Gabb.

Cret. B.—Martinez and Clayton, Contra Costa County; Griswolds, San Benito County; San Diego.

Fusus aratus Gabb.

Cret.—Millville, Shasta County; Martinez, Contra Costa County.

Fusus averilli Gabb.

Cret.—Tuscan Springs, Tehama County.

Fusus californicus Conrad.

Cret. B.—Lower Lake, Lake County; Clayton, Contra Costa County; Tejon, Kern County.

Fusus diaboli Gabb.

Cret. B.—Near Mt. Diablo, Contra Costa County; Tejon, Kern County.

Fusus flexuosus Gabb.

Cret.—Martinez, Contra Costa County.

Fusus kingi Gabb.

Cret.—Sucia Island, B. C.; Cottonwood Creek, Siskiyou County.

Fusus martinez Gabb.

Cret. B.—Martinez, Contra Costa County; Tejon, Kern County; San Diego.

Fusus occidentalis Gabb.

Cret.—Martinez, Contra Costa County.

Fusus tumidus Gabb.

Cret.—Martinez, Contra Costa County.

Gari ? texta Gabb.

Cret.—Martinez, Contra Costa County.

Globiconcha remondi Gabb.

Cret.—Benicia, Solano County.

Gryphæa vesicularis Lamarck.

Cret.—San Luis Rey to San Diego; Eastern States and Europe.

Gyrodes expansa Gabb.

Cret.—Jacksonville, Oregon; Siskiyou Mountains, Cottonwood Creek, Shasta County; Tuscan Springs, Tehama County; Pentz, Butte County; Texas Flat, Placer County; Lower Lake, Lake County; Martinez, Contra Costa County.

Haydenia impressa Gabb.

Cret.—Tuscan Springs, Tehama County; Pentz's, Butte County.

Helcion circularis Gabb.

Cret.—Martinez, Contra Costa County.

Helcion dichotoma Gabb.

Cret.—Texas Flat, Placer County.

Helicancylus æquicostatus Gabb.

Cret.—Cottonwood Creek, Alderson's Gulch, and Eagle Creek, Shasta County.

Helicaulax bicarinata Gabb.

Cret.—Cottonwood Creek, Shasta County.

Helicaulax costata Gabb.

Cret.—Martinez, Contra Costa County.

Helicoceras breweri Gabb.

Cret.—Pentz's, Butte County.

Helicoceras declive Gabb.

Cret.—Pentz's, Butte County.

Helicoceras vermicularis Gabb.

Cret.—Martinez, Contra Costa County.

Heteroterma trochoidea Gabb.

Cret.—Martinez, Contra Costa County.

Homomya concentrica Gabb.

Cret.—Sucia Island, B. C.; Cottonwood Creek, Shasta County; Tuscan Springs, Tehama County; Martinez, Contra Costa County.

Inoceramus elliotti Gabb.

Cret.—Alcatraz Island, San Francisco County; Alameda County.

Inoceramus whitneyi Gabb.

Cret.—Millville, Shasta County; Folsom, Sacramento County.

Leda gabbi Conrad.

Cret. B.—Martinez, Clayton, Contra Costa County; Griswold's, San Benito County; Tejon, San Emidio Cañon, Kern County.

Leda translucida Gabb.

Cret.—Cow Creek, Shasta County.

Lima appressa Gabb.

Cret.—Pacheco Pass, Merced County.

Lima microtis Gabb.

Cret.—Cottonwood Creek, Shasta County; Texas Flat?, Placer County.

Lima multiradiata Gabb.

Cret. B.—Departure Bay, B. C.?; Lower Lake, Lake County; Santiago Cañon, Santa Anna Mountains, Los Angeles County.

Lima shastaensis Gabb.

Cret.—Cottonwood Creek, Shasta County.

Limopsis transversa Gabb.

Cret.—Texas Flat, Placer County.

Liocium punctatum Gabb.

Cret.—Colusa County.

Lithophagus oviformis Gabb.

Cret.—Cow Creek, Shasta County.

Loxotrema turrita Gabb.

Cret. B.—Griswolds, San Benito County; San Diego.

Lucina? cretacea Gabb.

Cret. B.—Clayton to Marsh's Creek, Contra Costa County.

Lucina cumulata Gabb.

Cret.?—Tejon, Kern County.

Lucina nasuta Gabb.

Cret.—Sucia Island, B. C.; Martinez, Contra Costa County.

Lucina postradiata Gabb.

Cret.—Texas Flat, Placer County.

Lucina subcircularis Gabb.

Cret.—Sucia Island, B. C.; Texas Flat, Placer County.

Lunatia avellana Gabb.

Cret.—Cottonwood Creek, Shasta County.

Lunatia horni Gabb.

Cret. B.—Tejon Pass, Kern County; San Diego.

Lunatia nuciformis Gabb.

Cret. B.—Clayton, Contra Costa County; Tejon Pass, Kern County; San Diego?

Lunatia shumardiana Gabb.

Cret. B.—Lower Lake, Lake County; Martinez, Contra Costa County.

Lutraria truncata Gabb.

Cret.—Chico Creek, Pentz's, Butte County.

Lysis duplicosta Gabb.

Cret.—Texas Flat, Placer County.

Mactra tenuissima Gabb.

Cret.—Martinez, Contra Costa County.

Margaritella angulata Gabb.

Cret.—Martinez, Contra Costa County.

Margaritella crenulata Gabb.

Cret. B.—San Diego.

Margaritella globosa Gabb.

Cret.—Benicia, Solano County.

Martesia clausa Gabb.

Cret.—Vancouver Island, B. C.; Pentz's, Butte County; Tuscan Springs, Tehama County; Texas Flat, Placer County.

Meekia navis Gabb.

Cret.—Chico Creek, Pentz's, Butte County; Martinez, Contra Costa County.

Meekia radiata Gabb.

Cret.—Jacksonville, Oregon; Siskiyou Mountains; Tuscan Springs, Tehama County; Chico Creek, Butte County; Orestimba Cañon, Stanislaus County; Pacheco's Pass, Merced County.

Meekia sella Gabb.

Cret.—Siskiyou Mountains; Tuscan Springs, Tehama County; Martinez, Contra Costa County.

Megistostoma striatum Gabb.

Cret. B.—Martinez; San Diego.

Meretrix arata Gabb.

Cret.—Siskiyou Mountains; Cottonwood Creek, Shasta County; Orestimba Cañon, Stanislaus County.

Meretrix californica Conrad.

Cret. B.—Tejon, Kern County.

Meretrix fragilis Gabb.

Cret.—Martinez, Contra Costa County.

Meretrix horni Gabb.

Cret. B.—Tejon Pass, Kern County; San Diego.

Meretrix lens Gabb.

Cret.—Hornby and Sucia Islands, B. C.; Chico Creek, Butte County; Santa Ana Mountains, Los Angeles County.

Meretrix longa Gabb.

Cret.—Texas Flat?; Placer County.

Meretrix ovalis Gabb.

Cret. B.—Tejon, Kern County.

Meretrix uvasana Conrad.

Cret. B.—Martinez, Mount Diablo, Contra Costa County; Griswold's, New Idria, San Benito County; Tejon, Kern County; San Diego.

Mitra cretacea Gabb.

Cret. B.—Martinez, Contra Costa County.

Modiola cylindrica Gabb.

Cret.—Tuscan Springs, Tehama County; Pentz's, Butte County.

Modiola major Gabb.

Cret.—Lake and Colusa Counties.

Modiola ornata Gabb.

Cret. B.—Hornby and Sucia Islands, B. C.; Martinez, Mount Diablo, Contra Costa County; Griswold's, New Idria, San Benito County; Tejon, Kern County.

Modiola siskiyouensis Gabb.

Cret.—Jacksonville, Oregon; Siskiyou Mountains.

Morio (Sconsia) tuberculatus Gabb.

Cret. B.—Millville, Shasta County; Martinez, Clayton, Contra Costa County; Griswold's, San Benito County; Tejon, Kern County; San Diego.

Mysia? polita Gabb.

Cret. B.—Martinez, Clayton, Contra Costa County; New Idria, San Benito County; Tejon, Kern County.

Mytilus ascia Gabb.

Cret. B.—Tejon, Kern County.

Mytilus humerus Conrad.

Cret. B.—Tejon, Kern County.

Mytilus pauperculus Gabb.

Cret.—Sucia Island, B. C.; Martinez, Contra Costa County.

Mytilus quadratus Gabb.

Cret.—Tuscan Springs, Tehama County; Martinez, Contra Costa County.

Nassa antiquata Gabb.

Cret. B.—Martinez, Contra Costa County.

Nassa cretacea Gabb.

Cret. B.—Martinez, Contra Costa County; ten miles west of Griswold's, San Benito County; Tejon, Kern County.

Natica uvasana Gabb.

Cret. B.—Tejon, Kern County.

Naticina obliqua Gabb.

Cret. B.—Martinez, Contra Costa County; Tejon, Kern County; San Diego.

Nautilus texanus Shumard.

Cret.—Cottonwood Creek, Alderson Gulch, Shasta County; Mt. Diablo, Contra Costa County; Texas.

Neæra dolabræformis Gabb.

Cret.—Martinez, Contra Costa County.

Netihea grandicosta Gabb.

Cret.—Cottonwood Creek, Shasta County.

Neptunea (Tritonofusus) cretacea Gabb.

Cret. B.—Martinez, Contra Costa County.

Neptunea curvirostris Gabb.

Cret.—Cow Creek, Shasta County.

Neptunea? gracilis Gabb.

Cret. B.—Martinez, Contra Costa County.

Neptunea mucronata Gabb.

Cret.—Martinez, Contra Costa County.

Neptunea? supraplicata Gabb.

Cret. B.—Clayton, Contra Costa County; San Diego.

Nerinæa dispar Gabb.

Cret.—Cottonwood Creek, Shasta County.

Nerita cuneata Gabb.

Cret.—Tuscan Springs, Tehama County.

Nerita deformis Gabb.

Cret.—Cottonwood Creek, Shasta County.

Nerita (Theliostyla) triangulata Gabb.

Cret. B.—New Idria, San Benito County; near San Luis Rey to San Diego.

Neverita globosa Gabb.

Cret. B.—Millville, Shasta County; Griswold's; New Idria, San Benito County.

Neverita secta Gabb.

Cret. B.—Tejon, Kern County.

Nucula solitaria Gabb.

Cret.—Queen Charlotte's Island, B. C.; Texas Flat, Placer County.

Nucula traskana Meek.

Cret.—Vancouver Island, B. C.; Mount Diablo, Contra Costa County.

Nucula (Acila) truncata Gabb.

Cret.—Vancouver and other islands, B. C.; Tuscan Springs, Tehama County; Chico Creek; Pentz's, Butte County; Texas Flat, Placer County; Martinez, Contra Costa County; Pacheco's Pass, Merced County; Tejon, Kern County.

Olivella mathewsoni Gabb.

Cret. B.—Martinez; Clayton, Contra Costa County; Griswold's, San Benito County; Tejon, Kern County; San Diego.

Ostrea appressa Gabb.

Cret. B.—Mendocino County.

Ostrea breweri Gabb.

Cret.—Cow Creek, Shasta County; Santa Ana Mountains, Los Angeles County.

Ostrea idriaensis Gabb.

Cret. B.—New Idria, San Benito County; San Diego.

Ostrea malleiformis Gabb.

Cret.—Jacksonville, Oregon; Cottonwood Creek, Siskiyou County.

Palæatractus crassus Gabb.

Cret.—Near Sulphur Springs, Colusa County.

Patella traski Gabb.

Cret.—Texas Flat, Placer County.

Pecten californicus Gabb.

Cret.—Cottonwood Creek, Shasta County.

Pecten complexicosta Gabb.

Cret.—Morgan Valley, Lake County.

Pecten interradiatus Gabb.

Cret. B.—New Idria, San Benito County.

Pecten martinezensis Gabb.

Cret.—Martinez, Contra Costa County.

Pecten operculiformis Gabb.

Cret.—Cottonwood Creek, Shasta County; south of Mount Diablo.

Pecten traski Gabb.

Cret.—Vancouver Island, B. C.; Texas Flat, Placer County.

Perissolax blake? Conrad.

Cret. B.—Martinez, Mount Diablo, Contra Costa County; Tejon, Kern County; San Diego.

Perissolax brevirostirs Gabb.

Cret.—Sucia Island, B. C.; Tuscan Springs, Tehama County; Pentz's Ranch, Butte County; Lower Lake, Lake County; Martinez, Contra Costa County.

Pharella alta Gabb.

Cret.—Martinez, Contra Costa County.

Pholadomya breweri Gabb.

(*P. royano* D'Orbigny?)

Cret.—Vancouver and other islands, B. C.; Pentz's Ranch, Butte County; France?

Pholadomya nasuta Gabb.

Cret.—Martinez, Contra Costa County.

Pholadomya oregonensis Gabb.

Cret.—Siskiyou Mountains.

Pinna breweri Gabb.

Cret.—Cottonwood Creek, Siskiyou County; Cottonwood Creek, Shasta County; Martinez, Mt. Diablo, Contra Costa County; Santa Ana Mountains, Los Angeles County.

Pleuromya papyracea Gabb.

Cret.—Cottonwood Creek, Shasta County.

Plicatula variata Gabb.

Cret.—Battle Creek, Shasta County.

Potamides diadema Gabb.

Cret.—Cottonwood Creek, Shasta County.

Potamides tenuis Gabb.

Cret.—Denman and Sucia Islands, B. C.; Pentz's Ranch, Butte County.

Ptiloteuthis foliatus Gabb.

Cret.—Cottonwood Creek, Shasta County.

Pugnellus hamulus Gabb.

Cret.—Martinez, Contra Costa County.

Pugnellus manubriatus Gabb.

Cret.—Cottonwood Creek, Siskiyou County.

Rhynchonella whitneyi Gabb.

Cret. B.—Lake and Colusa Counties.

Rimella canalifera Gabb.

Cret. B.—Martinez, Contra Costa County; Tejon, Kern County.

Rimella simplex Gabb.

Cret. B.—Clayton, Contra Costa County; San Diego.

Ringicula varia Gabb.

Cret.—Cow Creek, Shasta County.

Ringinella pinguis Gabb.

Cret.—Martinez, Contra Costa County.

Ringinella polita Gabb.

Cret.—Colusa County.

Scalaria (Opalia) mathewsoni Gabb.

Cret. B.—Sucia Island, B. C.; Martinez, Contra Costa County.

Septifer dichotomus Gabb.

Cret. B.—Tejon, Kern County.

Siliqua oregonensis Gabb.

Cret.—Siskiyou Mountains.

Siphonodentalium pusillum Gabb.
(*Gadus pusillus* Gabb.)

Cret. B.—Martinez, Contra Costa County; Tejon, Kern County.

Solarium wallalense White.

Cret.—Wallala, Mendocino County.

Solen (Hypogella) cuneatus Gabb.

Cret.—Martinez, Contra Costa County.

Solen (Hypogella) diegoensis Gabb.

Cret. B.—San Diego.

Solen parallelus Gabb.

Cret.—Martinez and Marsh's, Contra Costa County; Tejon, Kern County.

Spirocrypta pileum Gabb.

Cret. B.—New Idria, San Benito County; Tejon, Kern County.

Stalagmium concentricum Gabb.

Cret. B.—Martinez, Contra Costa County.

Straparollus lens Gabb.

Cret.—Texas Flat, Placer County.

Straparollus paucivolvis Gabb.

Cret.—Texas Flat, Placer County.

Surcula claytonensis Gabb.

Cret. B.—Clayton, Contra Costa County; Tejon, Kern County.

Surcula inconspicua Gabb.

Cret.—Martinez, Contra Costa County.

Surcula mathewsoni Gabb.

Cret.—Martinez, Mount Diablo, Contra Costa County.

Surcula præattenuata Gabb.

Cret. B.—San Diego.

Surcula raricostata Gabb.

Cret. B.—Vancouver Island, B. C.; Clayton, Contra Costa County.

Surcula sinuata Gabb.

Cret. B.—Tejon, Kern County.

Sycodes cypræoides Gabb.
(*S. glaber* Shumard?)

Cret.—Vancouver and Sucia Islands, B. C.; Tuscan Springs, Tehama County; Texas Flat, Placer County.

Tapes conradiana Gabb.

Cret. B.—Lower Lake, Lake County; Martinez, Clayton, Contra Costa County; Griswold's, San Benito County; Tejon, Kern County.

Tapes? cretacea Gabb.

Cret. B.—Corral Hollow, Alameda County.

Tapes? quadrata Gabb.

Cret. B.—Martinez; Clayton, Contra Costa County; Tejon, Kern County.

Tellina æqualis Gabb.

Cret.—Martinez, Contra Costa County.

Tellina ashburneri Gabb.

Cret.—Millville, Shasta County; Pentz's, Butte County.

Tellina californica Gabb.

Cret. B.—Marsh's, Contra Costa County; Tejon, Kern County.

Tellina decurtata Gabb.

Cret.—Pentz's, Butte County.

Tellina hoffmanniana Gabb.

Cret.—Pentz's, Butte County; Martinez, Contra Costa County; Griswold's, San Benito County.

Tellina horni Gabb.

Cret. B.—Clayton, Contra Costa County; Tejon, Kern County.

Tellina longa Gabb.

Cret. B.—Martinez, Clayton, Marsh's, Contra Costa County; Tejon, Kern County.

Tellina mathewsoni Gabb.

Cret.—Vancouver Island, B. C.; Millville, Shasta County; Martinez, Contra Costa County.

Tellina monilifera Gabb.

Cret.—Texas Flat, Placer County.

Tellina ooides Gabb.

Cret.—Pentz's, Butte County; Martinez, Contra Costa County.

Tellina parilis Gabb.

Cret.—Martinez, Contra Costa County.

Tellina quadrata Gabb.

Cret.—Hornby Island, B. C.; Tuscan Springs, Tehama County.

Tellina remondi Gabb.

Cret. B.—Martinez, Mt. Diablo, Contra Costa County; Tejon, Kern County.

Tellina? undulifera Gabb.

Cret.—Martinez, Contra Costa County.

Tellina (Sanguinolaria) whitneyi Gabb.

Cret.—Jacksonville, Oregon.

Terebra californica Gabb.

Cret. B.—Martinez, Contra Costa County.

Terebratella obesa Gabb.

Cret.—Queen Charlotte's Island, B. C.; Texas Flat, Placer County.

Tessarolax distorta Gabb.

Cret.—Vancouver Island, B. C.; Tuscan Springs, Tehama County.

Thetis elongata Gabb.

Cret.—Cottonwood Creek, Shasta County.

Trapezium carinatum Gabb.

Cret.—Texas Flat, Placer County.

Trigonia æquicostata Gabb.

Cret.—Oregon; Cottonwood Creek, Shasta County; Martinez and south of Mount Diablo, Contra Costa County; Orestimba Cañon, Stanislaus County.

Trigonia evansana Meek.

Cret.—Vancouver Island, B. C.; Oregon; Siskiyou Mountains; Cottonwood Creek, Shasta County; Tuscan Springs, Tehama County; Chico Creek and Pentz, Butte County; Texas Flat, Placer County; Rag Cañon, Lake County; Benicia, Solano County; Martinez, Contra Costa County; Orestimba Cañon, Stanislaus County; Pacheco Pass, Merced County; Santa Ana Mountains, Los Angeles County.

Trigonia leana Gabb.

Cret.—Jacksonville, Oregon; Martinez, Contra Costa County; South America?

Trigonia tryoniana Gabb.

Cret.—Vancouver Island, B. C.; Tuscan Springs, Tehama County.

Tritonium californicum Gabb.

Cret. B.—Tejon, Kern County; San Diego.

Tritonium (Trachytriton) diegoense Gabb.

Cret. B.—San Diego.

Tritonium (Trachytriton) fusiforme Gabb.

Cret. B.—Tejon, Kern County.

Tritonium horni Gabb.

Cret. B.—Near Mt. Diablo, Contra Costa County; Tejon, Kern County.

Tritonium paucivaricatum Gabb.

Cret. B.—Tejon, Kern County.

Tritonium (Trachytriton) tejonensis Gabb.

Cret. B.—Tejon, Kern County.

Tritonium whitneyi Gabb.

Cret. B.—Tejon, Kern County; San Diego.

Turbinella crassitesta Gabb.

Cret.—Martinez, Contra Costa County.

Turnus plenus Gabb.

Cret.—Cottonwood Creek, Shasta County; Pacheco's Pass, Merced County.

Turritella chicoensis Gabb.

Cret.—Chico Creek, Butte County.

Turritella infragranulata Gabb.

Cret.—Martinez, Contra Costa County.

Turritella infralineata Gabb.

Cret.—Cottonwood Creek, Shasta County; Orestimba Cañon, Stanislaus County.

Turritella martinezensis Gabb.

Cret. B.—Martinez, Contra Costa County.

Turritella robusta Gabb.

Cret.—Tuscan Springs, Tehama County.

Turritella saffordi Gabb.

Cret.—Lower Lake, Lake County; near Suisun, Solano County; Martinez, Contra Costa County; Tennessee; New Jersey.

Turritella seriatim-granulata Rœmer.

Cret.—Cottonwood Creek, Siskiyou County; Cottonwood Creek, Shasta County; Tuscan Springs, Tehama County; Santa Ana Mountains, Los Angeles County; Arivechi, Mexico; Texas.

Turritella uvasana Conrad.

Cret.—Martinez, Contra Costa County; Griswolds, San Benito County; Tejon, Kern County; San Diego.

Unio penultimus Gabb.

Cret. B.—Coal mines near Clayton, Contra Costa County.

Urosyca caudata Gabb.

Cret.—Martinez, Contra Costa County.

Venus æquilateralis Gabb.

Cret. B.—Near San Luis Rey to San Diego.

Venus lenticularis Gabb.

Cret.—Benicia, Solano County; Mount Diablo, Contra Costa County.

Venus tetrahedra Gabb.

Cret.—Tuscan Springs, Tehama County.

Volutilithes navarroensis Shumard.

(Fulguraria elongata? D'Orbigny.)

Cret.—Jacksonville, Oregon; Siskiyou Mountains; Cow Creek, Shasta County; Tuscan Springs, Tehama County; Chico Creek, Butte County; Texas; France? India?

CRETACEOUS AND EOCENE RADIATA.

Astrocœnia? petrosa Gabb.

Cret.—Martinez, Contra Costa County.

Flabellum remondianum Gabb.

Cret.—Clayton, Contra Costa County.

Smilotrochus curtus Gabb.

Cret.—Martinez, Contra Costa County.

Trochosmilia (Acrosmilia) striata Gabb.

Cret. B.—Clayton, Contra Costa County.

Trochosmilia (Ellipsosmilia) granulifera Gabb.

Cret.—Chico Creek, Butte County.

JURASSIC MOLLUSCA.

Ammonites colfaxii Gabb.

Jur.—Colfax, Placer County; Robinson's Ferry, Stanislaus County.

Astarte ventricosa Meek.

Jur.—Genesee Valley, Plumas County.

Amussium aurarium Meek.

Jur.—Mariposa.

Aucella erringtoni Gabb.

Jur.—Mariposa to Coulterville, Mariposa County.

Belemnites pacificus Gabb.

Jur.—Mariposa to Coulterville, Mariposa County; Spanish Flat, El Dorado County.

Inoceramus obliquus Meek.

Jur.—Genesee Valley, Plumas County.

Inoceramus rectangulus Meek.

Jur.—Genesee Valley, Plumas County.

Lima? cuneata Meek.

Jur.—Genesee Valley, Plumas County.

Lima recticostata Meek.

Jur.—Genesee Valley, Plumas County.

Lima sinuata Meek.

Jur.—Genesee Valley, Plumas County.

Myacites depressus Meek.

Jur.—Genesee Valley, Plumas County; Volcano, Nevada.

Mytilus multistriatus Meek.

Jur.—Genesee Valley, Plumas County.

Pecten acutiplicatus Meek.

Jur.—Genesee Valley, Plumas County.

Pholadomya orbiculata Gabb.

Jur.—Mariposa.

Rhynchonella gnathophora Meek.

Jur.—Genesee Valley, Plumas County.

Trigonia pandicosta Meek.

Jur.—Genesee Valley, Plumas County.

Unicardium gibbosum Meek.

Jur.—Genesee Valley, Plumas County.

TRIASSIC MOLLUSCA.

Arcestes gabbi Meek.

Tri.—Humboldt County, Nevada; Plumas County, California?

Ammonites billingsianus Gabb.

Tri.—Humboldt County, Nevada; Plumas County, California.

Ammonites homfrayi Gabb.

Tri.—Humboldt County, Nevada; Plumas County, California.

Ammonites ramsaueri Quenstedt.

Tri.—Gifford's, Plumas County; Humboldt, Nevada.

Avicula homfrayi Gabb.

Tri.—Star City, Humboldt County, Nevada; Plumas County, California.

Avicula mucronata Gabb.

Tri.—Gifford's, Plumas County.

Ceratites haidingeri Hauer.

Tri.—Humboldt County, Nevada; Plumas County, California?

Clydonites lævidorsatus Hauer.

Tri. ?—Spanish Flat, El Dorado County?; Coloma, Amador County; White Mountains, Inyo County, California; near Dayton, Nevada.

Corbula blakei Gabb.

Tri.—Humboldt County, Nevada; Plumas County, California.

Gymnotoceras blakei Gabb.

Tri.—Near Star City, Humboldt County, Nevada; Plumas County, California?

Halobia dubia Gabb.

Tri.—Gifford's, Plumas County, California; Star City, Humboldt County, Nevada.

Monotis subcircularis Gabb.

Tri.—Gifford's, Plumas County, California; Star City, Humboldt County, Nevada; Vancouver Island and Peace River, British Columbia.

Myacites (Panopœa) humboldtensis Gabb.

Tri.—Gifford's, Plumas County, California; Humboldt County, Nevada.

Myophoria alta Gabb.

Tri.—Dun Glen, Humboldt County, Nevada; Plumas County, California?

Mytilus homfrayi Gabb.

Tri.—Dun Glen, Humboldt County, Nevada; Plumas County, California?

Nautilus multicameratus Gabb.

Tri.—Dun Glen, Humboldt County, Nevada; Plumas County, California?

Nautilus whitneyi Gabb.

Tri.—Buena Vista, Humboldt County, Nevada; Plumas County, California?

Orthoceratites blakei Gabb.

Tri.—Buena Vista, Humboldt County, Nevada; Volcano, Nevada; Plumas County, California.

Pecten deformis Gabb.

Tri.—Giffords, Genesee Valley, Plumas County, California.

Posidonomya daytonensis Gabb.

Tri.—Near Dayton, Nevada; Plumas County, California?

Posidonomya stella Gabb.

Tri.—Star City, Humboldt County, Nevada; Plumas County, California?

Rhynchonella æquiplicata Gabb.

Tri.—Cinnabar, Humboldt County, Nevada; Plumas County, California?

Rhynchonella lingulata Gabb.

Tri.—Star City, Humboldt County, Nevada; Plumas County, California.

Rhynchopterus obesus Gabb.

Tri.—Near Humboldt City, Nevada.

Spirifer homfrayi Gabb.

Tri.—Star City, Humboldt County, Nevada; Plumas County, California?

Terebratula humboldtensis Gabb.

Tri.—Star City, Humboldt County, Nevada; Plumas County, California?

Trachyceras whitneyi Gabb.

Tri.—Humboldt County, Nevada; Plumas County, California?

CARBONIFEROUS MOLLUSCA.

Euomphalus (Omphalotrochus) whitneyi Meek.

Carb.—Shasta County.

Productus giganteus Martin.

Carb.—McCloud River, Shasta County; Europe.

Productus semireticulatus Martin.

Carb.—Flathead Valley (latitude 49°), British Columbia; Shasta County, California; Missouri?; South America; England; Ireland.

Retzia compressa Meek.

Carb.—Shasta County.

Spirifer lineatus? Martin.

Carb.—Shasta County; Iowa; England; Ireland.

CARBONIFEROUS RADIATA.

Clisiophyllum gabbi Meek.

Carb.—Shasta County.

Lithostrotion californiensis Meek.

Carb.—Shasta County.

Lithostrotion mamillare? Castelnau.

Carb.—Shasta County; Mississippi Valley.

CARBONIFEROUS PROTOZOA.

Fusulina cylindrica Fischer.

Carb.—Bass Ranch, Shasta County; British Columbia; Russia.

Fusulina gracilis Meek.

Carb.—Bass Ranch, Shasta County.

Fusulina robusta Meek.

Carb.—Bass Ranch, Shasta County.

ADDITION TO MAMMALIA (page 224).

Morotherium giganteum Marsh.

Pl.—"Central California." An extinct sloth, which may have made the tracks like gigantic human footprints found in the Carson quarry.

TERTIARY PLANTS.*

ACER—Maple.

Acer æquidentatum Lesquereux.

Pl.—Chalk Bluffs, Nevada County; Colorado; Greenland.

---

*Note.—The uncertainty of evidence as to the age of formations, is greater when derived from plants, than from animal remains. Several species are here added from the United States government reports, now in preparation. Professor Lesquereux has revised this catalogue.

Acer arcticum Heer.

Pl. and Mioc.—Chalk Bluffs, Nevada County; Forest City, Sierra County; Bad Lands, Nebraska; Alaska; Arctic Zone.

Acer bendirei Lesquereux.

Mioc.—Monte Cristo Tunnel, Spanish Peak, Plumas County.

Acer bolanderi Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Acer sextianum Saporta.

Pl.?, Mioc., and Eocene.—Chalk Bluffs, Nevada County; France.

ALNUS—Alder.

Alnus corralina Lesquereux.

Pl. and Mioc.—Corral Hollow, Alameda County; John Day Valley, Oregon.

Alnus kefersteini Gœppert.

Mioc.—Shasta County, California; Wyoming; Arctic Zone; Europe.

ARALIA—Spikenard.

Aralia acerifolia Lesquereux.

Pl. and Mioc.—Chalk Bluffs, Nevada County; Bad Lands, Nebraska.

Aralia angustiloba Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Aralia lasseniana Lesquereux.

Mioc.—Lassen County.

Aralia whitneyi Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Aralia zaddachi Heer.

Pl. and Mioc.—Chalk Bluffs, Nevada County; Europe.

BETULA—Birch.

Betula æqualis Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

CARYA—Hickory.

Carya bilinica Unger.

Mioc.—Monte Cristo Tunnel, Spanish Peak, Plumas County, California.

CASTANEA—Chestnut.

Castanea ungeri Heer.

Mioc.—Rock Corral, Placer County; Corral Hollow, San Joaquin County; British Columbia; Alaska; Greenland; Europe.

Castanopsis chrysophylloides Lesquereux.

Pl.—Chalk Bluffs, Nevada County. Like the Chinquapins.

Cercocarpus antiquus Lesquereux.

Pl.—Table Mountain, Tuolumne County. Like "Mountain Mahogany."

CINNAMOMUM—Cinnamon.

Cinnamomum affine Lesquereux.

Mioc.—Corral Hollow, San Joaquin County; Colorado; Carbon, Wyoming Territory; Europe.

Cinnamomum scheuchzeri Heer.

Mioc.—Lassen County, California; Wyoming; Europe.

COLUTEA—Bladder-senna.

Colutea boweniana Lesquereux.

("*C. oregonensis*" in Catalogue Hayden's Survey, p. 272.)

Mioc.—"Bowen's Claim, Oregon." (Professor Whitney and C. D. Voy state that this claim is in Nevada County, California.)

CORNUS—Dogwood.

Cornus hyperborea Heer.

Mioc.—Lassen County, California; Arctic Zone.

Cornus kelloggii Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Cornus ovalis Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Diospyros virginiana Linnæus.

(var. *turneri* Lesquereux.)

Mioc.—Contra Costa County. Apparently a variety of the eastern persimmon.

FAGUS—Beech.

Fagus antipofi Heer.

Pl. and Mioc.—Table Mountain, Tuolumne County; British Columbia; Alaska; Europe.

Fagus pseudo-ferruginea Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

FICUS—Fig.

Ficus asiminæfolia Lesquereux.

Mioc.—Rock Corral, Placer County.

Ficus appendiculata Heer.

Mioc.—Lassen County.

Ficus microphylla Lesquereux.

Pl.—Table Mountain, Toulumne County.

Ficus sordida Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Ficus tiliæfolia Al. Brogniart.

Pl.?, *Mioc.*, *and Eocene*—Forest City, Sierra County; Chalk Bluffs, Nevada County; Carbon, Wyoming; Colorado; Bad Lands, Dakota; Europe.

Geonomites schimperi Lesquereux.

Mioc. and Eocene—Contra Costa County, California; Yellowstone Lake, Wyoming. An extinct palm tree.

ILEX—Holly.

Ilex prunifolia Lesquereux.

Pl.—Table Mountain, Tuolumne County.

JUGLANS—Walnut.

Juglans californica Lesquereux.

Pl.—Chalk Bluffs, Nevada County. (Not the living species of same name; but the fossil has priority.)

Juglans egregia Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Juglans aurinea Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Juglans oregoniana Lesquereux.

Pl. and Mioc.?—Oregon; Chalk Bluffs, Nevada County.

Juglans rugosa Lesquereux.

Mioc.—Lassen County; Wyoming; Montana.

LAURUS—Laurel.

Laurus californica Lesquereux.

Mioc.—Corral Hollow, San Joaquin County; Monte Cristo Tunnel, Spanish Peak, Plumas County. (Not the living "California Laurel," *Oreodaphne.*)

Laurus furstenbergi Al. Brogniart.

Mioc.—Corral Hollow, San Joaquin County.

Laurus grandis Lesquereux.

Mioc.—Corral Hollow, San Joaquin County.

Laurus princeps Heer.

Mioc.—Corral Hollow, San Joaquin County; Europe.

Laurus resurgens ? Saporta.

Mioc.—Corral Hollow, San Joaquin County; Montana.

Laurus salicifolia Lesquereux.

Mioc.—Corral Hollow, San Joaquin County.

Laurus socialis Lesquereux.

Mioc.—Lassen County; Wyoming.

LIQUIDAMBAR—Sweet Gum.

Liquidambar californicum Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

MAGNOLIA.

Magnolia californica Lesquereux.

Pl. and Mioc.—Chalk Bluffs, Nevada County; Lassen County; Contra Costa County.

Magnolia inglefieldi Heer.

Mioc.—Lassen County; Wyoming.

Magnolia lanceolata Lesquereux.

Pl.—Chalk Bluffs, Nevada County; Forest City, Sierra County.

MYRICA—Wax Myrtle.

Myrica ungeri Heer.

Mioc.—Monte Cristo Tunnel, Spanish Peak, Plumas County.

MYRTUS—Myrtle.

Myrtus oregonensis Lesquereux.

Mioc.—Corral Hollow, San Joaquin County; Oregon?

OREODAPHNE—Mountain Laurel.

Oreodaphne heeri Gaudichaud.

Mioc.—Lassen County.

Oreodaphne litseæformis Lesquereux.

Mioc.—Lassen County.

PERSEA—Alligator Pear.

Persea dolleri Lesquereux.

Mioc.—Shasta County, California.

Persea pseudo-carolinensis Lesquereux.

Mioc.—Corral Hollow, Alameda County.

Persea punctulata Lesquereux.

Mioc.—Corral Hollow, Alameda County.

Phragmites œningensis Al. Brogniart.

Mioc.—Lassen County; Colorado; New Mexico; Arctic Zone; Europe. A species of cane.

PLATANUS—Sycamore.

Platanus appendiculata Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Platanus dissecta Lesquereux.

Pl.—Chalk Bluffs, Nevada County; Table Mountain, Tuolumne County.
Mioc.—Monte Cristo Tunnel, Plumas County.

POPULUS—Poplar.

Populus balsamoides Goeppert.

Pl. ? and Mioc.—Corral Hollow, San Joaquin County; Alaska; Wyoming; Bad Lands, Dakota; Europe.

Populus zaddachi Heer.

Pl. ?, Mioc., and Eocene—Chalk Bluffs, Nevada County; Bad Lands, Dakota; Colorado; Alaska; Greenland; Spitzbergen; Europe.

Pterospermites spectabilis Heer.

Mioc.—Monte Cristo Tunnel, summit of Spanish Peak, Plumas County.

QUERCUS—Oak.

Quercus boweniana Lesquereux.

Pl.—Bowen's Claim, Nevada County.

Quercus convexa Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Quercus distincta Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Quercus elænoides Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Quercus furcinervis Rossmassler.

Mioc. and Eoc.—Plumas County, California; Bridge Creek and Cascade Mountains, Oregon; Greenland; Europe.

Quercus goepperti Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Quercus moorii Lesquereux.

Mioc.—Lassen County, California; Mississippi.

Quercus nevadensis Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Quercus olafseni Heer.

Pl. and Mioc.—Table Mountain, Tuolumne County, and Lassen County, California; Bad Lands, Dakota; Utah; Greenland.

Quercus pseudo-chrysophylla Lesquereux.

Pl.?—Forest City, Sierra County. Living? (*Q. densiflora ?* living.)

Quercus pseudo-lyrata Lesquereux.

Pl.—Chalk Bluffs ?, Nevada County.

Quercus steenstrupiana ? Heer.

Pl. and Mioc.—Forest City, Sierra County; Arctic; Greenland.

Quercus transgressa Lesquereux.

Pl.?—Forest City, Sierra County. Living? (=*Q. chrysolepis?* living.)

Quercus voyana Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

RHUS—Sumach.

Rhus boweniana Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Rhus dispersa Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Rhus heufleri Heer.

Mioc.—Corral Hollow, Alameda County.

Rhus metopioides Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Rhus mixta Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Rhus myricæfolia Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Rhus typhinoides Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Sabalites californicus Lesquereux.

Pl.—Chalk Bluffs, Nevada County. An extinct kind of Palmetto.

SALIX—Willow.

Salix californica Lesquereux.

Pl. ?—Table Mountain, Tuolumne County.

Salix elliptica Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Salix integra Goeppert.

Mioc.—Corral Hollow, San Joaquin County; Europe.

Salix varians Goeppert.

Pl., *Mioc.*, *and Eoc.*—Table Mountain, Tuolumne County; Corral Hollow, San Joaquin County; Alaska; Greenland; Europe.

Sequoia angustifolia Lesquereux.

Mioc.—Corral Hollow, San Joaquin County. A kind of Redwood.

Taxites olriki Heer.

Mioc.—Corral Hollow, San Joaquin County; Alaska; Greenland; Spitzbergen. Resembling the yew trees.

ULMUS—Elm.

Ulmus californica Lesquereux.

Pl.—Chalk Bluffs, Nevada County; Table Mountain, Tuolumne County.

Ulmus affinis Lesquereux.

Pl.—Table Mountain, Tuolumne County.

Ulmus pseudo-fulva Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Viburnum whymperi? Heer.

Mioc.—Shasta County; Wyoming; Alaska? Related to the Laurestinus.

Zanthoxylon diversifolium Lesquereux.

Pl.—"Bowens claim," Oregon; Nevada County, California. Like the eastern "Toothache Tree."

ZIZYPHUS—Lotus Tree.

Zizyphus microphyllus Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

Zizyphus piperoides Lesquereux.

Pl.—Chalk Bluffs, Nevada County.

CRETACEOUS PLANT.

Juglans debeyana Heer.

Cret. (possibly Eocene).—Rock Corral, Placer County; "100 feet deep in cretaceous rocks;" Dakota; Colorado. Leaflets only known, not unlike those of *J. regia.*

INDEX.

A

B

C

D

E

T

V

W